clear of the trestle. These aprons were of steel plate, bolted to the side sill. They had a slope of 45° and extended about 2½ ft. from the side of the car.

All the filling and ditching mentioned herewith are under the direction of L. E. Gagnon, Superintendent of Maintenance-of-Way. R. L. Cooper is Chief Engineer.

Ingenious Special Devices for Tunnel Surveys

Interesting special devices are employed in the survey work on two new tunnels now under construction in Milwaukee, Wis. One of them is a tunnel instrument table that is easily placed, easily taken down and that, when in use, does not block the operation of the muck-cars. In connection with it are points of novelty in the tunnel marks and the way of using them. These are features of the Shore tunnel of the new Linwood Ave. intake under Lake Michigan, north of the North Point pumping station. A similar system of marks is used in the Lake St. sewer tunnel in the northern part of the city. A new thing in this tunnel is a sighting fork for giving tunnel center-line grades from the roof marks.

Handy Instrument Table

The instrument table in the Shore tunnel serves as a support for either transit or level. The timber track floor laid inside the concrete lining of the tunnel is not steady enough to permit setting the instrument tripod on it, and an extension tripod set against the tunnel ring beyond the floor would block the haulage track. The portable table was designed by Lee G. Warren, resident engineer, to meet these conditions. It is wholly above car clearance and gives rigid support on the concrete lining.

The table, Fig. 1, consists of a 5x1¾-in. board transverse to the tunnel and somewhat shorter than its diameter, which is carried by and slides between two parallel ⅝-in. round steel bars 4½ in. apart and about 9 ft. long. Near one end each bar has a turnbuckle. By means of this the bars can be expanded or contracted to set them against the wall or release them. The ends of the bars are pointed, so that they can seat firmly in shallow pits or conical depressions chipped in the concrete wall of the tunnel. The bars extend along the sides of the table board and are held to it by metal straps and loops screwed to the board. The board is about 18 in. shorter than the bars, and near one end it has a long fine-thread brass adjusting screw engaging an abutment block in the board and a nut fastened to a crossbar fixed on the side bars. By this means the table board can be shifted transverse to the tunnel axis and the instrument centered accurately on the longitudinal axis of the tunnel.

Near the middle of the board is fastened a tripod head, which is used directly to carry the level. To mount

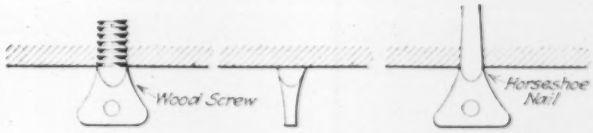


FIG. 2. NAIL OR SCREW ROOF-MARKS USED IN MILWAUKEE TUNNELS

the transit, a Berger cross-slide head is screwed on the fixed head. The screw-control slide adjustment of this special head enables the instrument to be moved parallel to the tunnel axis and thus makes it possible to center

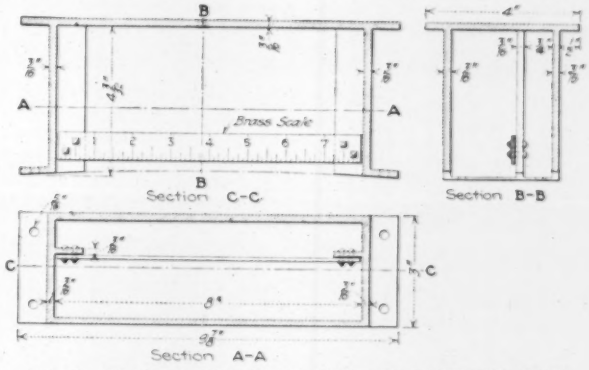


FIG. 3. SCALE ROOF-MARK USED IN LINWOOD AVE. TUNNEL

the telescope directly under the point of the plumb-bob suspended from the roof marks.

Before setting the table in place, two keel marks are made on the side of the tunnel at the proper point, and shallow depressions are then chipped in the concrete at the marks to furnish a secure seating for the ends of the bars. Then the table is lifted up, and the bars are expanded into the depressions. The instrument is at convenient height for observing, and the clearance under the table is sufficient for the ¾-yd. tunnel cars.

As the concrete lining in this tunnel is kept close up to the excavation face, survey marks are needed in the concrete only. About every 60 ft. a short block of 2x4 is concreted in the crown of the arch flush with the under

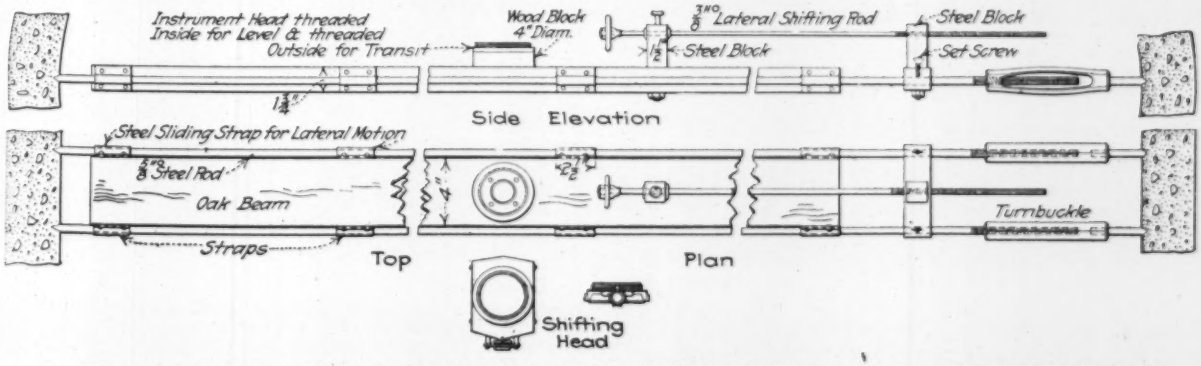


FIG. 1. QUICK-SHIFT TUNNEL INSTRUMENT TABLE USED IN LINWOOD AVE. TUNNEL, MILWAUKEE

surface, and later an alignment mark is screwed into the block. The mark is a woodscrew whose head has been forged flat and pierced with a $\frac{1}{16}$-in. hole, to serve as sighting point or to hold a plumb-bob cord. It is said to be not difficult to set these screws on center line (by transit sight) accurately enough for lining in the heading work and the forms. The two points nearest the face have plumb-bobs swung in them all the time until the next two points ahead have been set, and alignment of the headings and forms forward is obtained at any time by sighting past the cords.

For lining in to grade, similar screw points are set at springing line on both sides of the tunnel barrel. Strings stretched across the tunnel between the opposite points give the means of sighting forward and lining in the front of the concreting form to correct elevation.

Permanent Survey Marks with Scale and Vernier

Permanent roof marks for the accurate prolongation of the tunnel survey are set about every 125 ft. The mark is a cast-iron box concreted in the arch flush with its under surface, with a brass scale transverse to the tunnel axis fixed permanently in this box, as shown by Fig. 3. The scale is graduated to tenths of an inch, and it is read to one-hundredths by a portable vernier plumb-bob hook, not shown in the sketch. This vernier hook is carried by the engineer and is slipped over the scale for alignment sights, the vernier reading being recorded when the plumb-bob cord is on center line.

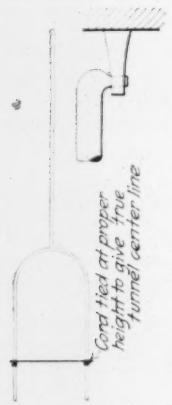


FIG. 4. GRADE-SIGHTING FORK

There is special need for accurate work in the alignment in this tunnel, because one of the shafts is driven about 30 ft. off the tunnel and reaches the tunnel by a crossdrift. Further, the tunnel makes an angle just at the point of entry of this drift; to insure correct running of the two headings from this shaft, therefore, rather accurate instrument work is required.

The permanent roof mark is also used for the definite reading of grades. Elevations are taken against the under side of the scale in the roof mark by means of an inverted level rod.

All headings of this tunnel are driven with compressed air. A roof mark is set in each air lock.

Roof-Mark System in Lake St. Sewer Tunnel

The Lake St. sewer tunnel, whose headings are worked under atmospheric pressure, has no permanent roof-mark system, but uses for both temporary and permanent service a roof mark like those employed by the inspectors in the Shore tunnel. There is a difference, however, in that the Shore tunnel roof marks are made of woodscrews with flat head, while R. H. Cahill, resident engineer of the Lake St. sewer tunnel, uses horseshoe nails with head similarly shaped and perforated.

These marks are set in pairs, 16 ft. apart along the tunnel, with an interval of 60 to 100 ft. between successive pairs. The pair nearest the heading excavation is used for sighting forward for the heading alignment and for aligning the forms. The theory of the arrangement is that it is fairly easy to sight along two strings that are only 16 ft. apart. On the other hand, it is not necessary to establish a new sighting pair every 16 ft., the interval of about 80 ft. being found very satisfactory.

For giving grade, side marks are not thought necessary, but the same roof marks are used by the help of a novel device, Fig. 4. It consists of a fork 3½ ft. long, made of light steel rod, with a hook-shaped lateral projection at the end of the straight or handle portion, this projection being about $\frac{1}{16}$ in. in diameter so as to fit into the perforation of the roof mark. When the fork hangs on the roof mark, a string stretched across the tines of the fork furnishes an excellent sighting point for grade. The string is adjusted for a given roof mark until it is just on tunnel center line, according to transit sight. The fork is then kept in just this adjustment (a record of the distance from hook to string is also noted) so long as grade sights need to be taken at this point. Hanging the proper forks at the two roof marks 16 ft. apart, a sight is taken forward over the two cords onto the front end of the concreting form until this is brought up to true tunnel grade. The headings are kept in grade and line by the foreman sighting by the marks.

Acknowledgments for information are due to the resident engineers, R. H. Cahill and Lee G. Warren, and to George F. Staal, City Engineer of Milwaukee, under whose general direction both pieces of work are being carried out.

Flange Makeup Diagrams for Heavy Plate Girders

Where heavy plate girders have to be designed, the labor of making up various trial flange sections can be eliminated by using the two diagrams shown on the opposite page. They give net areas of all cover-plate combinations (of 14-in. and 16-in. width) with 6x6-in. angles.

Ordinates represent total net sectional area; the several vertical lines are the successive thicknesses of angle. Each inclined line denotes a particular cover-plate section.

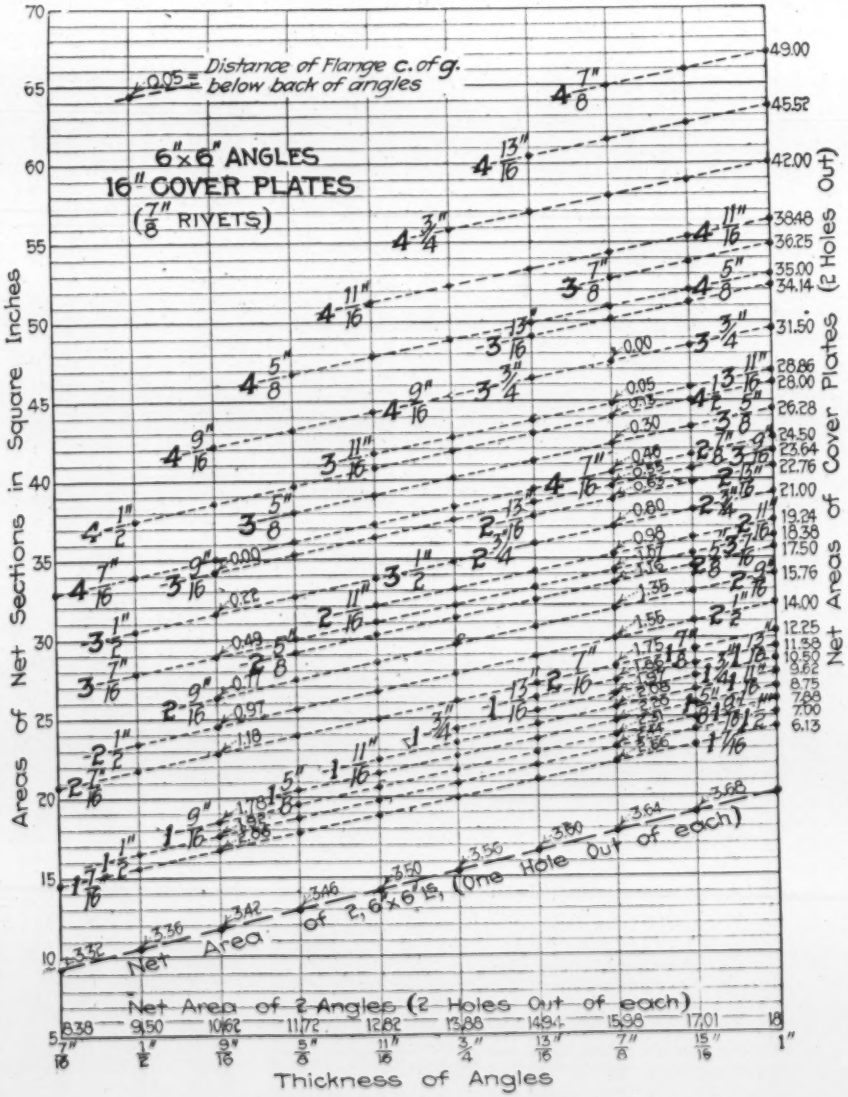
To compute effective depth of the girder, the distance from back of angle to center of gravity of flange is given for two of the angle sizes; intermediate values are easily interpolated.

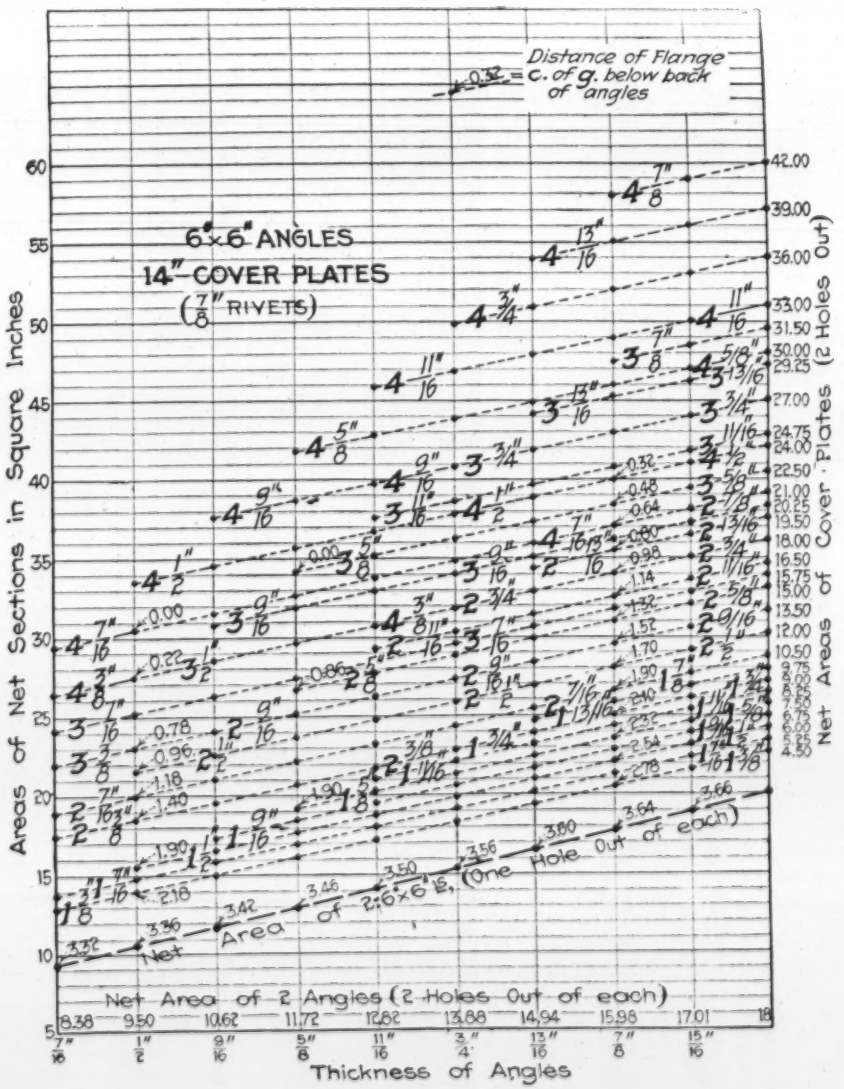
The cover plate area alone (with two holes out of each plate) is given by the column of figures at the right. The angle area with two holes out of each angle is given by a row of figures at the bottom; the area with one hole out of each angle may be read off the lowest sloping line, which represents a flange without cover plates.

Where a flange is to have a specified minimum percentage of angle area, the figures at the bottom should be used for net area, as the angles then have a hole in each leg.

The diagrams were devised by H. J. Finebaum, of the Engineering Department of the New York Municipal Railway Corporation. Similar diagrams for other sizes of angle or other plate widths can easily be made up by the reader. The two given are believed to cover the most common needs.

Flooded Basements Charged to Railway—On July 28, 1914, 4 in. of rain fell at Dickinson, N. D., in a 9-hr. period. The water backed up on the north side of a fill of the Northern Pacific Ry. The Supreme Court of North Dakota has just ruled that the railway was negligent, in failing to provide a culvert of sufficient dimension to carry away the flood. The damages were estimated at $50,000. The defense maintained that the cloudburst was an element they should not be compelled to take into consideration in building a culvert.


6"×6" ANGLES
16" COVER PLATES
(7/8" RIVETS)
Distance of Flange c. of g. below back of angles
Areas of Net Sections in Square Inches
Net Areas of Cover Plates (2 Holes Out)
Net Area of 2 Angles (2 Holes Out of each)
Net Area of 2, 6"×6" L's, (One Hole Out of each)
Thickness of Angles

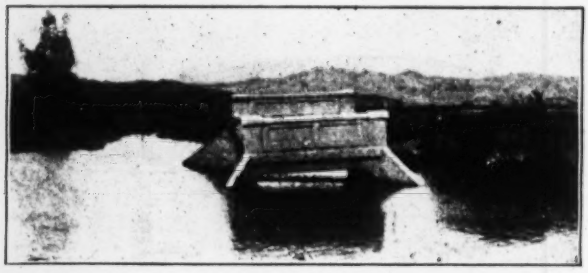

6"×6" ANGLES
14" COVER PLATES
(7/8" RIVETS)
Distance of Flange c. of g. below back of angles
Areas of Net Sections in Square Inches
Net Areas of Cover Plates (2 Holes Out)
Net Area of 2 Angles (2 Holes Out of each)
Net Area of 2, 6"×6" L's, (One Hole Out of each)
Thickness of Angles

FLANGE-MAKEUP DIAGRAMS FOR HEAVY PLATE-GIRDERS; 6x6-IN. ANGLES WITH 14-IN. AND 16-IN. COVER-PLATES—H. J. FINEBAUM

Total net sections, two holes out of each angle and each plate; 1-in. holes for 7/8-in. rivets

NOTES

An Undermined Culvert on the Albay-Camarines Interprovincial road, Philippine Islands, is shown in the view. This damage occurred in the latter part of 1915, when a large por-



CONCRETE CULVERT UNDERMINED BUT INTACT

tion of southern Luzon was swept by a typhoon (Oct. 23, 1915). The concrete culvert of 4-m. span apears to be structurally intact in spite of the rough treatment it has undergone.

Cylinder Drops for Irrigation Ditches are being tried out on the Rio Grande project, United States Reclamation Service. They are of two types. One is shown in detail in Fig. 1. It consists of a grated concrete stop or baffle chamber, under which are a concrete box and a concrete flume outlet. The water entering the upper chamber falls into the box below through two circular openings in the floor. Over these open-

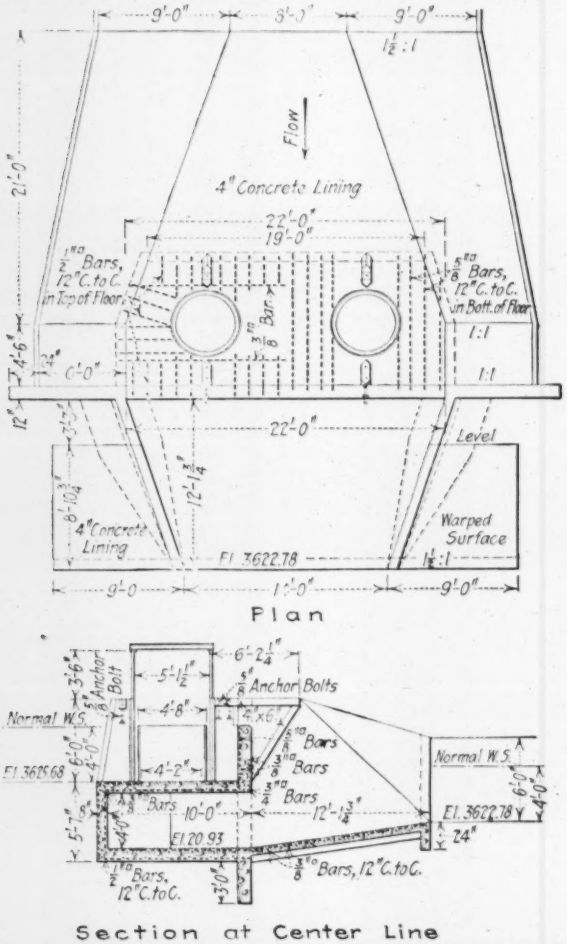


FIG. 1. CYLINDER DROP GATE BEING TRIED ON CANALS OF RIO GRANDE RECLAMATION PROJECT

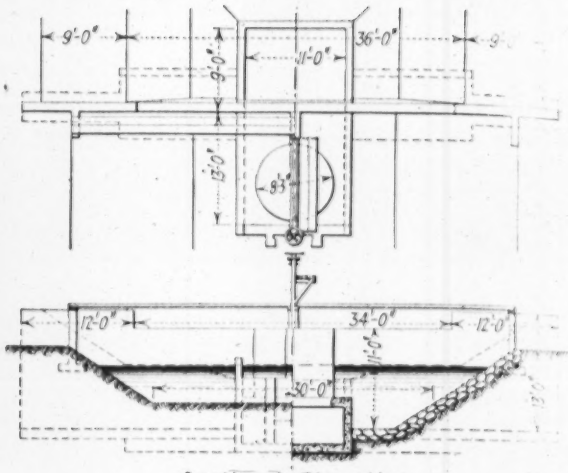
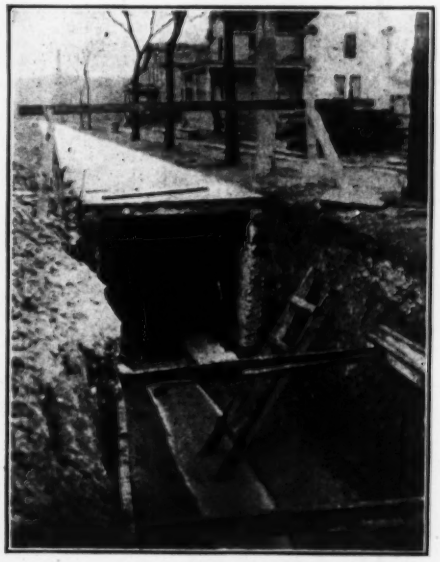


FIG. 2. CYLINDER DROP GATE OF THE FOUNTAIN TYPE

ings are two steel cylinders that can be raised or lowered by a triplex hoist hung from a crossbeam over the cylinder. The cylinders are held in place by guides. The flow can be controlled with considerable precision by means of these drop gates. The second type of cylindrical drop gate being tried is similar to the first, except that the flow is up through the cylindrical gate (Fig. 2) instead of down, as in Fig. 1. This latter is known as the fountain type. The first type has been given use enough so that it may be called successful, although slight changes are made as new ones are installed. The second type, however, has not been thoroughly tried out. R. F. Walter is project manager of the Rio Grande project, and W. A. Perkins is designing engineer.

A Combined Sidewalk, Curb and Storm Sewer is now under construction at Ann Arbor, Mich., as shown by the accompanying view. The top slab, or sidewalk and sewer roof, is 6 in. thick and has 0.15 sq.in. of reinforcement per foot. The walls and invert are also 6 in. in thickness. The invert has sides on a 2 to 3 slope, joined by a curve of 1½-ft. radius. The interior width is 5 ft. The height of the verti-



SIDEWALK, CURB AND STORM SEWER IN ONE STRUCTURE, ANN ARBOR, MICH.

cal side walls averages about 5 ft. The invert is laid on a 3% grade. The grade of the sidewalk, however, and the drops at street crossings are taken care of by varying the heights of the walls. This sewer was designed in the office of Manley Osgood, City Engineer of Ann Arbor, and is being constructed under his direction.—Donald A. Thomas, 836 East University Ave., Ann Arbor, Mich.

Editorials

Steady Progress of American Water-Works Association

The steady progress of the American Water-Works Association during the last few years is a fit subject for congratulation. Its membership has increased rapidly; for a yearly deficit it has substituted a handsome surplus; it has formed about a half-dozen geographical sections, with more in prospect, and has established a chemical and bacteriological section; it now publishes a good quarterly journal; and the exhibits of water-works appliances at the conventions have been increased in number and usefulness—thanks to the Water-Works Manufacturers' Association.

The indications of progress just named were notable facts a year ago, when *Engineering News*, directly after the Cincinnati convention, asked a question which has kept tongues and pens going more or less constantly ever since. That question was: "Can the American Water-Works Association Find Itself?"

At the convention held last week in New York City, President Hill devoted half of his able retiring address to the points raised in the *Engineering News* editorial and to some points raised by another technical journal a few weeks ago, which took the earlier article as its text. This portion of Mr. Hill's remarks is printed in full elsewhere in this issue. Although at one place in his speech Mr. Hill asserted in effect that he wished to make public denial of the "charges" that had been brought against the association, yet his address as a whole contained a number of statements and appeals that show that the American Water-Works Association has not yet found itself. We do not, however, wish to press this point. We recognize the force of the comment made by Mr. Hill that the American Water-Works Association is not the only organization of the kind that is trying to find itself.

Brief consideration may be given to some of the opportunities for further progress urged by Mr. Hill in the opening part of his address, not reprinted in this issue. First, there is the vast field for increase in membership. Mr. Hill pointed out that only some 500 water-works of the United States and Canada are represented in the association, whereas there are at least 6,000 such works in existence. Obviously, many of the 6,000 water-works are very small, but if only half of them were to be represented in the association and that by only one member each, there would be an addition of 2,500 members. There are many works that are now represented by several members and some that might well have, to put it modestly, from 5 to 25 members each.

It is pertinent to ask, Why should an association over 35 years old have less than 1,500 members today, when it has 6,000 water-works to draw from, to say nothing of the thousands of engineers, manufacturers and supplymen whose interests center largely in the water-works field? The most obvious answer is that either what the association has to offer to water-works men does not seem to them to be of sufficient interest and value to take at the price or else that the association fails in making the value of its membership known to the rank and file of the water-works men of the United States and Canada. We shall not attempt to say whether failure lies in either the one or the other or perceptible in both of these directions.

Another need strongly urged by Mr. Hill was for an editor for the "Journal," in order to relieve the secretary from double service and enable him to give more time to the general work of the association, including membership campaigns. This suggestion certainly deserves most earnest consideration, but would not the present exigencies be met best by a single full-time secretary-editor? Heretofore, "permanent headquarters" in New York City or some other expensive center have seemed to be considered necessary to a full-time secretary—to say nothing of a full-time editor. A modest and inexpensive office, if need be in some relatively small city, might serve as "headquarters" for a few years. If it be urged that the finances of the association do not warrant even this expenditure, then it may be asked, What of the $4,000 gain in surplus funds reported for the past year?

A third line of progress suggested by President Hill was the provision of funds for committee work. An apparent falling off in the committee work was mentioned in these columns a year ago, and most of the committee reports at the New York convention last week were of the "progress" character. A lack of funds certainly had nothing to do with the failures of some committees to report and with the meager character of a number of the reports that were made.

Why, it seems fair to ask, should practically no appropriation whatever have been made for committee work heretofore and only $500 be recommended in the budget for the coming year, if the association is able to increase its surplus by $1,000 in a single year?

Other points might be discussed, but perhaps enough has been said to show that, while the American Water-Works Association has made steady progress in the past few years and is doubtless finding itself, there is still occasion for such searching examination of the aims and needs of the association as was presented by Mr. Hill in his notable address.

Carbon Steel Scores a Point

The "silicon steel" of the Metropolis bridge seems to show in its test performance such high qualities as have generally been credited to alloy steels alone. The table of tests and analyses from the regular acceptance routine for the bridge, printed in the last issue of *Engineering News*, indicates results that are quite as remarkable as the original announcement of a new material for the great structure.

Manganese and carbon can furnish strength more cheaply than a metal like nickel. If by the influence of a slight raise in silicon the steel can then be made

tractable, the inducement to use expensive alloys for high strength will be greatly lessened.

Departure from the standard 60,000-lb. bridge steel seems almost the regular thing nowadays. In the Hell Gate and in the Metropolis and Sciotoville truss bridges carbon steels of extra strength are employed. All three are squarely within the range of magnitude that in all recent discussions of alloy steels has been set apart as the particular field of these special materials. If carbon steel with the advantage of low cost can thus crowd alloy steels out of the bridge field before they have fairly entered it, new paths of development may be looked for in the art of building steel structures.

The Fruits of Parsimony

The Plattsburg dam failure, described in *Engineering News* last week, well illustrates the egotism of political wiseacres who rush in where an engineer dares not tread. The city fathers of Plattsburg, the same Plattsburg which has been so well advertised as the home of military preparedness, in their infinite wisdom abolished the office of city engineer, plugged the weep holes of a leaking dam built on glacial drift and, figuratively, thumbed their noses at any who had the temerity to suggest impending danger.

Astonishing as is such a performance, it can only be regarded as the crowning achievement of a parsimonious movement in city government (a reform and an economy the officials themselves probably would claim) which has been evident before in that city. The preceding administration nominally had a city engineer and a consulting engineer, but it overloaded the former by imposing on him the burden of design and inspection of this dam and it restricted the latter by accepting advice only as to the suitability of an earth dam on the site they had selected. These politicians refused to compare the disadvantages of the selected site and of others which might have been possible; they refused to consider the experience of contractors as dam builders and discarded the suggestion that a consulting engineer should check the design and supervise construction of the dam. Possibly they relied too much on the protection afforded by the apparently perfunctory approval of a State Conservation Commission restricted in its powers and limited in its appropriations. They did not even give the city engineer a resident inspector but persisted in requiring him personally to watch the construction while maintaining the street, bridge, sewer and water-works service of this active town of 12,000 inhabitants.

Passing to the technical aspects of the failure, it does not appear that the dam was poorly designed, once it is assumed that the site was imperative. The cut-off wall might readily have been deeper, particularly near the ends where the spacing of the steps makes the net depth at places less than the 20 ft. called for in the middle of the dam. A reinforced cut-off wall or at least a heavy reinforcement of the connection of wall to deck might have been included, but this would have been beyond the standard practice of the time or even of today. Finally, in view of the character of the ground some sort of paving or fore-apron would have been a desirable insurance.

In the construction one bad oversight seems to have been permitted. The trench sheeting for the cut-off wall was left in place if not for the whole length of the dam, at least for a large part of it, and the backfilling was anything but thorough. In consequence, there was perhaps a fairly open path for the water to traverse down and up the sides of the cut-off wall; if so the primary object of such a wall was lost. Even in placing the later puddled trench alongside of the wall the error was not rectified, for in places on the exposed wall the sheeting planks are now plainly visible.

Dams on porous foundations are ticklish things at best. In design, in construction and in maintenance, they require the most expert supervision. That such supervision was not present at Plattsburg is due to the non-technical city officials. This fiasco is depressing, of course, to all who hope to see intelligent municipal government spread, but doubtless it will teach a lesson, at least through the length and breadth of the Champlain valley, on the economics of spigot-saving and bunghole wasting.

Traffic Capacity Limited by Unloading Facilities

That the traffic capacity of a great railway system may be limited by the unloading facilities of those who receive freight over its lines is clearly brought out in a circular just issued by President Howard Elliott, of the New Haven railroad. In connection with the efforts of that company to reduce the delays in freight shipments, President Elliott says:

> As a chain is no stronger than its weakest link, so is the capacity of a railway no greater than the capacity of its terminal facilities. This in turn is limited by the facilities of consignees and their ability to load and unload cars placed for them. Consequently the capacity of a railway to transport freight is measured by the rate at which cars are loaded and unloaded.

From the figures presented by President Elliott, it appears that for several months the capacity of the railroad to handle freight has been restricted by the slow unloading of freight by consignees. During the months of November and December last the average number of cars on the New Haven line in position for unloading each day was from 10,000 to 11,000. The average daily number of cars unloaded was 5,500. During March and April there was an increase in the average number of cars in position for unloading daily to 12,000 and 13,000, but the average daily rate of unloading fell to 4,200 to 4,300.

C. E. Clark, of the Interstate Commerce Commission, estimates that the traffic capacity of the New Haven system has decreased 50% by reason of slow unloading by consignees. President Elliott points out that the slow rate of unloading compared with the delivery of the cars has resulted in congestion on the unloading tracks and the connecting yards, making switching difficult. The congestion has also made it necessary to set out 2,000 to 4,000 cars at intermediate stations on the road, blocking the tracks there and delaying train movements. There were 1,000 to 3,000 cars similarly delayed at terminals, and from 10,000 to 15,000 cars delayed on connecting lines.

In examining the causes of the slow unloading it appears evident that one important cause is the congestion itself. When merchants or manufacturers know that there is likely to be delay in the shipment and re-

ceipt of goods, they order in advance of their requirements and often bring in goods faster than they are able to unload them. The start of the freight congestion appears to have been the very heavy orders for coal placed early in the year in anticipation of a possible coal strike.

It has long been understood by transportation experts that the capacity of a railway line is determined by its terminal facilities. The present experience of the New Haven company shows that a railway's capacity is dependent not only on the terminal facilities which the railway company itself controls, but on the freight-handling facilities of many hundreds or thousands of consignees along its lines.

Horse Cars To Disappear In New York City

For many years one of the curiosities shown visitors to New York City has been the few surviving lines of horse cars, which have continued in operation in the city where urban travel is far more dense than in any other city of the world, nearly a score of years after such vehicles disappeared almost everywhere else in the country. According to an announcement in the official publication of the New York Public Service Commission, the New York Railways Co. proposes to eliminate the last horse car from the streets of New York City this year. It is proposed that some appropriate celebration be made of the final abandonment of metropolitan horse-car transportation.

This antiquated device has persisted in New York City because of peculiar conditions which are not always understood beyond the metropolis. Overhead contact wires are taboo in Manhattan and the required underground conduit system is economical only for very dense traffic. About every form of self-propelled vehicle has been tried, including compressed-air and generations of storage-battery cars; the one exception seems to be the rail automobile in jitney form, though there was tried an experimental gasoline-engine electric motor street car which proved less economical than the modern light-weight storage-battery car with anti-friction journals. These cars have been used in increasing numbers here for three years.

High Plate-Girder Stresses

Though the plate-girder is popular, its claims of advantage are rarely given due recognition. When practical bridge problems lead to the use of such enormous plate-girder structures as the Worcester viaduct described in these pages last week, there does not appear to be much need of additional propaganda for the type. Yet the fact remains that plate-girders are never—or hardly ever—fully credited with their superior factor of safety over other bridge types.

If a list of badly over-stressed steel structures could be compiled, plate-girders would occupy a prominent place in the list. They withstand great amounts of unanalyzed abuse, and they rarely fail. The question is whether they should not receive a distinct preference in unit-stress on this account.

The very intricacy of the plate-girder from the structural point of view is responsible for its physical advantage over truss construction. Its parts hang together so intimately that most of the detail possibilities of failure existing in other steelwork are neutralized. Secondary stress, concentrations of stress not amenable to analysis, and local weakness due to composite character of cross-section or whatnot, have little or no meaning with respect to the plate-girder.

Truss design has constantly raised its permissible values for computed "direct" stress. Values are common today that greatly exceed the customary flange stresses for plate-girder construction. This condition ought to be reversed. A plate-girder structure of such arrangement of parts as to be secure against lateral yield, and protected against concealed rusting, should be allowed higher stresses than are permissible for any other form of riveted steelwork.

Comment was made in our issue of May 25 on a resolution of the Massachusetts Legislature directing the Public Service Commission of the state "to investigate the relations existing between railroads and railways in the commonwealth of Massachusetts." This resolution was decidedly mystifying to the average man who makes no distinction between these two words. A correspondent now informs us that the terms railroad and railway have been officially defined by a Massachusetts statute as follows:

> "Railroad" means a railroad or railway of the class usually operated by steam power.
>
> "Street railway" or "railway" means a railroad or railway, including poles, wires or other appliances and equipment connected therewith, of the class operated by motive power other than steam, and usually constructed in, under or above public ways and places.

It is certainly nice to have a legislature willing to supplement the work of the dictionary makers. Unfortunately, this brave attempt at precise definition leaves certain rail transportation lines in a "twilight zone." Suppose a line originally operated with steam locomotives is later changed to electric motive power. Does it thereby cease to be a "railroad" and become a "railway?" Is the New York, New Haven & Hartford a "railway" from New York City to New Haven, and a "railroad" the rest of the way to Boston? On some lines passenger trains have been hauled by electric traction, and freight trains by steam locomotives. Is such a line a railroad or a railway, under Massachusetts law? Again the law above quoted defines a "railroad" as "usually operated by steam power." But nearly all the electric railways in Massachusetts are operated by steam power. The electric current is merely a means of transmitting the power which is generated by steam in the central station to the wheels of the car or locomotive. What the framers of this Massachusetts statute really meant to say was that a railroad is a line usually operated by steam *locomotives*. It is painful to find such careless use of English under the shadow of the sacred codfish.

Each of the past three issues of *Engineering News* has contained an account of a dam failure. In each case the trouble lay with the foundation. This is not mere coincidence; it is the common history of dam failures. Amateurs in dam construction and maintenance who study and worry over the proper design of the section should note the fact.

Letters to the Editor

Sewer Pipe-Joint Question

Sir—The City of Durham is about to construct a standard 24-in. terra cotta sewer, through wooded, boggy land. This sewer line will carry sewage, dye waste and bleach liquor. A standard 10-in. terra cotta sewer will also be constructed through like country, carrying bleach liquor alone.

Our specifications have been drawn as follows:

In wet trenches and in quicksand and in such other places where directed by the engineer, the contractor shall furnish and use Jointite, GK or similar water-tight compounds. Where Jointite or GK compound is used the joint shall terminate at least ¼ in. back of the face of the bell, and a cement joint be made over it. The cement shall be protected by a bandage of cloth. The prices bid will be paid for such special joints. Where special joints are used three pipes may be joined together on the bank and laid at one time.

If the experience of your readers indicates that the cement collar on the outside of the joint is not needed, or throws any other light upon the proper joint to use under the conditions stated, I should be glad to have particulars given through your columns.

H. W. KUEFFNER,
Durham, N. C., June 3, 1916. City Engineer.

Claiming Over 100 Per Cent. Efficiency for a Pump

Sir—I notice in your issue of May 18, 1916, p. 950 an article entitled "Chain and Bucket Lift for Irrigation Water," describing the so-called "Famous Water Elevator," made in Denver, Colo. I quote as follows from the article: "In one plant now in operation, a 20-hp. gasoline engine in the altitude of Colorado raises 600 gal. per min. 135 ft."

If any of your readers will make the computation, they will find that 600 gal. per min. raised 135 ft. is the equivalent of 20⅓ hp. No gasoline engine will operate at more than its rated horsepower to say the least, at an altitude of 4,000 ft. (about the minimum altitude in Colorado) so that the published claim is equivalent to saying that the pump will operate at over 100% efficiency.

It is unnecessary to say to any engineer that neither this chain and bucket pump or any other pump ever made operates at 100% efficiency. Further, any engineer with any knowledge of machinery can see at a glance that any pump operating on this principle with its chain of dripping buckets, its numerous joints, its speed reduction gearing from the engine to the chain wheel, is bound to have considerable losses of power. He can see further that the wear and tear on the numerous joints exposed to water and grit, on the thin sheet iron buckets, and other parts will be pretty certain to make the cost of repairs and depreciation on such a pumping outfit very heavy.

Of course such an apparatus will operate and raise water, but what the irrigation farmer needs is a pumping outfit which will operate economically year in and year out and require the least adjustment and repairs. The irrigation farmer, however, generally knows little of mechanics and too often falls a victim to the shrewd salesman who claims that his particular pump will raise more water for a given expenditure of power than any other fellow's pump. When such claims creep into the columns of *Engineering News*, however, they should be promptly exposed and that is the object of this letter.

"IRRIGATION ENGINEER."
Salt Lake City, May 22, 1916.

Should Engineering Societies Pass on Public Questions?

Sir—The author of the article under this heading in Apr. 27, 1916, p. 818, of *Engineering News*, undoubtedly refers to the action taken by the Calgary branch of the Canadian Society of Civil Engineers in connection with the controversy over certain features of the construction of the large reinforced-concrete arch bridge now being built over the Bow River by this city.

The evident intent of the article is to create the impression that the society was not justified in taking the action which it did and that in so doing it was encroaching upon the rights of the consulting engineer.

The author passes over the facts of the case upon which the action of the society (of which he is a member) was based, with one or two statements which are misleading.

As the precedent established by the society in the attitude which it assumed is new, a concise statement of facts will be given in order that the profession may judge for themselves of the merits of the action.

For a period of nearly a year previous to the matter being taken up by the society there had appeared in the public press considerable adverse criticism of the engineering department of this city. This came principally from an alderman who had previously held the position of Water-Works Engineer for the city, but under a policy of economy his services had been dispensed with and the water-works department placed under the City Engineer. He thereupon entered politics and was elected an alderman. He also opened an office for the practice of consulting engineering; hence his statements and opinions regarding engineering matters received far more consideration from the public than otherwise would have been the case. The work of the city engineering department was greatly handicapped by this continual fault-finding.

Finally this criticism focused itself upon the construction of a large concrete arch bridge being built by the city over the Bow River at Centre St. and charges were made to the City Council by this alderman which reflected upon the ability and good judgment of those connected with the city engineering department.

The City Engineer was an Associate Member of the American Society of Civil Engineers and the local members of this organization, realizing the serious nature of this criticism, took the matter up with him, and after

hearing his side it was the unanimous opinion of those present that any further discussion of these matters in the daily press could serve no useful purpose and that the local engineering profession would lose prestige if it were allowed to continue.

Furthermore it was evident that if the facts were as he presented them, his reputation as an engineer was being attacked largely for political purposes. As this was a matter between engineers it was felt that it should be settled within the profession and that the local branch of the Canadian Society of Civil Engineers was the proper body to which to appeal. This would be quite fair as neither party to the controversy was connected with this organization and its membership was thoroughly representative of the local profession as well as containing some of the larger rate-payers of the city. At the same time the attention of the City Engineer was called to the fact that if the society could be prevailed upon to take the matter up, he must be prepared to abide by the findings of that body regardless of the consequences. With this understanding the whole matter was laid before the executive board of the local organization.

In the meantime the City Council had ordered the two Commissioners and Mayor to investigate the matter and report. The alderman had been prevailed upon to submit the verbal charges in writing and the City Engineer requested to answer them in the same manner.

In the interim between the submission of the charges and the answers, the executive board of the society unanimously decided to offer its services gratis to the board of commissioners to investigate and report on the matter. A set of resolutions embodying this offer were then drawn and adopted at a general meeting of the society. The city accepted the offer and requested the society to proceed.

Three members of the branch were then selected to act as a committee to make the investigation. The meetings were made public and held in the committee room of the council chamber at the City Hall and the proceedings were recorded by a stenographer furnished by the city. The alderman preferring the charges refused to appear before this committee for examination and they had no power to compel attendance. On the other hand the City Engineer, the engineer in charge of the design and construction of the bridge and the City Chemist, who had charge of the city testing laboratories, appeared and submitted very willingly to a thorough examination on the points at issue.

In brief the charges were as follows:

(a) The use of unsuitable rerolled steel in the structure and extravagance in the testing of same.

(b) Neglect or carelessness in not carrying the foundations of the north retaining wall to rock.

(c) Failure on the part of the engineering department to submit the design to a consulting engineer for endorsement, it having always been understood that such a course would be followed.

(d) The purchase of unsuitable cable for hoisting purposes during construction at a higher price than that at which suitable cable could be purchased.

The Commissioners assumed the responsibility for (d), thus relieving the committee from its consideration.

A few extracts from the findings of the committee will indicate how much foundation there was for these charges. These extracts are as follows:

As the impression conveyed by Ald ———'s charges is that the safety of the whole bridge has been jeopardized by the use of this rerolled steel the committee feel that this report is not complete without a statement as to what use was made or contemplated to be made of this steel. It has been used as reinforcement in the construction of the retaining wall which forms a part of the north abutment. It has also been used or is contemplated as dowels to furnish a bond between successive pourings of concrete in the river piers and springings. It was also used or contemplated in the curtain walls of the main piers and pylons of the river arches and as carrier or spacing rods in various other parts of the work. With the exception of the retaining walls, where its employment has already been covered by this report, the function of the steel is arbitrary and the material is subject to no definite stresses. In the pylons, the curtain walls are a mere architectural effect and have no structural functions. The steel is used merely to prevent unsightly cracks due to temperature and shrinkage stresses and its section is in most cases far in excess of possible requirements.

The statement has also been made by Ald. ——— that because the Centre St. bridge is larger than the Mission bridge, a better grade of material should be used. This is not correct. Mere size is no criterion, in fact the unit stresses in a large structure may be, and in this case actually are, less than in the smaller ones, and if anything a cheaper grade of material might be used with safety.

Taking up the charges in order as hereinbefore outlined the committee submits its opinions.

A. The question of unsuitable reinforcing material and extravagance in testing the same.

1. Cost of testing. The committee are of the opinion that the cost of testing will not be unreasonable and that in all probability it will be less than a similar service performed by an inspection company.

2. Quality of steel. The committee are of the opinion that the use of rerolled steel in certain parts of the structure was warranted on the grounds of economy and that in view of the relatively high grade of the material the integrity of the structure has not suffered in any particular.

B. In the matter of foundations of the north abutment or retaining wall. The committee are of the opinion that the failure of this wall, from the causes outlined by Ald. ——— is a very remote possibility, and that the wall is safe against failure from the other possible causes outlined in this report. The committee are also of the opinion that the additional cost of carrying this foundation to rock would not be justified by any extra security so obtained.

C. In the matter of employing consulting opinion. The committee were unable to find that any suggestion to this end was ever made by Ald. ——— or anyone else and they also find that if the understanding existed as stated by Ald. ——— it was not made public or communicated to the City Engineer. The committee further are of the opinion that such a course was not justified on the grounds of cost.

After carefully reviewing the statements of Ald. ——— the City Engineer's reply thereto, the record of tests of material, and the plans of the structure, as well as the work itself, and the evidence submitted, the committee wish to state that they can find no reason for the charges and are unable to understand why they should ever have been made.

The full report of the committee was filed with the city authorities and with the secretary of the parent society. The Commissioners and the City Council adopted the report and thanked the society for its assistance. The council of the parent society also expressed its approval of the manner in which the Calgary branch had handled the matter.

The local society has no apology to make for the action taken. On the other hand it believes that it has done a valuable service to the profession and the public in establishing this precedent and that if it was more generally understood that charges reflecting upon the ability of engineers in public office would have to pass the investigation of the local profession, that a great deal of unjust criticism would be avoided and the public relieved of a large amount of unnecessary worry.

SAM G. PORTER,
Secretary-Treasurer, Calgary Branch,
Canadian Society of Civil Engineers.

Calgary, Alberta, May 19, 1916.

Annual Meeting of American Water-Works Association

Evidences of increasing activity and prosperity were displayed at the 36th annual convention of the American Water-Works Association, held in New York City, June 5 to 9. With a treasury surplus of over $7,000, of which $4,000 has been invested in permanent securities, the association faces its most promising year. The gain in active membership during the last year—94 net—is also encouraging. Some 400 to 500 active members attended the convention; and the 60-odd manufacturers who had exhibits of water-works supplies and equipment made the convention a notable and attractive one. The total registration was about 1,200.

The address of the retiring President, Nicholas S. Hill, Jr., gave a summary of the year's work. He stated that the most useful field for the association was in committee work and suggested that the committees be distributed geographically instead of following the usual practice of distributing the membership on the committee geographically, for this would afford a better opportunity for committee members to get together. He recommended that as much of the funds available as possible be devoted to committee work by means of a regular budget system ($500 has been appropriated for the present year). He further recommended closer cooperation between the local sections and the parent society and the publication of a bi-monthly instead of a quarterly "Journal," as soon as funds would permit. The latter part of his address was an answer to editorial criticisms of the association in this and other engineering periodicals, an abstract of which appears elsewhere in this issue.

Election of Officers—Next Convention City

Leonard Metcalf, of Metcalf & Eddy, Consulting Engineers, Boston, Mass., who has recently completed his term as President of the New England Water-Works Association, was the unanimous choice for President. The keynote of Mr. Metcalf's brief address in accepting the presidency was closer coöperation and greater service of members of the association. He recommended the formation of local sections as one of the best means of accomplishing these ends.

The other officers elected are: Vice-President, Theodore A. Leisen, General Superintendent of the Board of Water Commissioners of Detroit; Trustees, F. W. Cappelen, City Engineer, Minneapolis, and M. L. Worrell, General Manager Water-Works, Meridian, Miss.; Treasurer (reëlected), James M. Caird, Chemist and Bacteriologist, Troy, N. Y.

The vote for the city in which to hold the next convention aroused the usual amount of interest. The final ballot, to the great joy of E. E. Davis, was for Richmond, Va., with 113 votes. St. Louis was second with 59 and Birmingham, Ala., third with 29.

Water Consumption and Water Waste

The committee on water consumption reported briefly that the present forms for water consumption were being revised to group similar conditions and separate manufacturing and domestic consumption. A paper "Prevention of Water Waste on Railroads," by C. R. Knowles, described what had been accomplished by one railway (the Illinois Central) by proper attention to this item of operating expense—an annual saving in its water accounts of nearly $35,000. The discussion included water waste in general and the need of bringing home to the consumer the actual cost of water waste to him individually.

A closely allied subject, the question of what percentage of a city's total water-supply should be accounted for, received a considerable part of the time devoted to superintendents' day. The general consensus of opinion seemed to be that when 70 to 75% of the water leaving the water-works was accounted for, the results were all that could be expected. Nevertheless, several instances were given, notably Cleveland, Ohio, where 88 to 90% of the water delivered to the mains was actually accounted for. This required that the city or town be 100% metered and that the water used for fires and street flushing also be fairly accurately measured.

Reports and Discussions on Standard Specifications

The committee on standard specifications for hydrants and valves reported that it was coöperating with a similar committee from the New England Water-Works Association and that the specifications of the two associations were now practically identical except for 4-in. hydrants. The revised specifications of the committee were adopted. The committee on standard fittings for water meters has fixed over-all meter lengths for meters up to 1½ in. The report was accepted and the committee continued.

Pumping machinery received a fair amount of discussion. A paper "Pumping Machinery; Test Duty versus Operating Results," by J. N. Chester, Pittsburgh, Penn., called attention to the usual inefficient operation of boiler and piping plants and the need of a high-level reservoir to make loads uniform. He said there should always be a thorough study of local conditions before adopting electrically driven pumping machinery.

Discussion of Pressure Filters

The paper "Pressure Filters," by Harold C. Stevens, was a remarshalling of the old arguments in favor of pressure filters. The discussion showed that there appears to be a certain field for this type of filter, but that the majority of the speakers favored its use only under exceptional conditions. A point urged was that chlorination as a supplementary process puts pressure filters on as safe a basis, bacterially, as those of the gravity type.

The chief economical use of pressure filters appears to be confined to small water supplies where one set of pumps can be eliminated and where preliminary coagulation and sedimentation are not necessary. Lack of proper supervision of these small plants was held to be a prime cause for the disrepute into which pressure filters have fallen.

A water-works convention without a discussion of the merits of leadite for water-main joints has become a thing of the past. The evidence developed at this meeting proved to be quite entirely in favor of the use of leadite. A paper by William C. Buck, "Experience with

Leadite in Jointing Cement-Lined Water Pipe," described in minute detail the method of handling and applying this material to obtain the best results. In answer to several questions, he stated that no difficulty was experienced in cutting out old or defective joints. For this purpose he had devised a special tool. The poor results which have sometimes been obtained with leadite were held to be largely accounted for by the prejudice of the old-time lead calkers. For this reason it was recommended that trained lead calkers be not employed when leadite was used, but that new men be specially trained in pouring joints with leadite.

Paying for Private Fire Service

Practically all of the first session of the superintendents' day was devoted to a discussion of nine questions regarding private fire services, most of which related to the mooted question of charge or no charge. The insurance companies were well represented and the discussion at times was quite animated. Few of the queries developed any definite answers which could be agreed upon. The insurance representatives did the most talking. Finally, a motion was passed to limit the remainder of the discussion to water-works superintendents. The superintendents seemed generally agreed that a 4-in. connection was ample for 400 sprinkler heads, and that $50 a year was a normal charge for a 4-in. connection. They also seemed of the opinion that the sprinkler service was a special service and should be paid for as such. There was, however, increasing evidence of a getting together spirit on the part of the insurance interests and the water-works men, and a committee of the Association will be appointed to work toward that end.

The paper of Dabney H. Maury on "Reservoirs" was a frank statement of several years' experience, going into details of construction of several of the reinforced-concrete type. This led to a general discussion of the subject of concrete reservoirs and experience in attempting to waterproof them.

Presentation of Data on Reduction in Typhoid

George A. Johnson, New York City, presented data showing the effect of the introduction of water filtration and other sanitary measures in reducing the typhoid death rate during the last 25 years, together with such convincing arguments in favor of water filtration that a motion was passed by the meeting to have the paper printed separately and made available for general distribution.

Mr. Johnson's proposal that state public health departments should accept plans for "any method of purification, tangibly guaranteed continuously to furnish a water complying with the law," met with stout resistance from several members.

The report of Prof. Albert F. Ganz, Chairman of the Committee on Electrolysis, stated that an increasing amount of damage to water mains was occurring and that street railways were the sole cause of it. The connecting of the rails to water-mains to furnish a return circuit was unreservedly condemned. He argued that the water-works officials should join hands with the other interested public-utility men in agreeing on the methods of mitigation. In the discussion on the report strong opposition to working with the Joint National Electrolysis Committee was expressed. This was pased on the fact that the committee includes street railway and allied public-utility interests and on the fear that the Association might in some way commit itself so as to render the collection of damages from electrolysis more difficult. The report of the committee was accepted, instead of being adopted. The convention also voted to continue the committee, but not until it was made clear that the membership might be changed if the Executive Committee of the Association sees fit.

E. P. Goodrich, of New York, presented a lengthy report on the features of water-works design which affect city planning. These mainly involve the joint use of lands for reservoir sites and parks, and the advantage of underground hydrants in cities which had no snowfall. The failure to find hydrants in the winter when covered with snow has been found to be the only really tenable argument against the adoption of underground hydrants.

Chemical and Bacteriological Section

Two well attended lively sessions were testimony to the wisdom of establishing a section for the chemists and bacteriologists. A half-dozen papers were presented. Charles P. Hoover, of Columbus, Ohio, was elected Chairman and John A. Kienle Secretary of the session.

Something new which promises to be of economic value at certain water-treatment plants was presented by Charles P. Hoover, in a paper on "Recovery of Spent Lime at the Columbus Water-Softening and Purification Works." Experiments indicate that by building and operating a $30,000 lime-recovery plant $9,000 a year can be saved, and the problem of preventing the choking of the Scioto River with lime sludge may also be solved. The general plan is to reduce the moisture content of the lime sludge (1) by means of settling basins and (2) by vacuum filters, after which the sludge is put through rotary kilns and thus recover (except when the sludge is muddy) more lime than was used to soften the water. When the sludge is muddy lime recovery will not be attempted. Instead, limestone will be burned to produce lime.

A sewage effluent better than the Croton water into which it is turned three miles above the aqueduct intake was described by T. D. Coffin and Frank E. Hale, of the Department of Water Supply, New York City. The plant was built and is operated by the City of New York to treat the sewage delivered to the plant by the village of Mt. Kisco. It includes bar screens, pumps, a grit chamber, settling tank, dosing apparatus, double contact beds, intermittent sand filters and chlorinating apparatus. It treats 200,000 to 600,000 gal. of sewage per day. The original cost was $70,000. The total bacterial reduction is almost 100%—but 20 p.p.m. of available chlorine are used after sedimentation, double contact and slow sand filtration.

The abolition of the presumptive test for B. coli, unless accompanied by confirmatory tests, was advocated by C.-E. A. Winslow, of New Haven, Conn., after reviewing late researches on the subject. Conservative views as to the wisdom of doing this were expressed in the discussion.

Less objection, in fact well-nigh aproval, was given to the proposal from another source to abandon the time-honored term, temporary hardness, and use alkalinity instead. The section finally decided to recommend the matter to committees of the American Chemical Society and the American Public Health Association.

Aims of American Water-Works Association Voiced*

By Nicholas S. Hill, Jr.†

SYNOPSIS—A presentation of the "broader aspects of the development" of the American Water-Works Association in form of an answer to a discussion started editorially in "Engineering News" of May 20, 1916, under the caption, "Can the American Water-Works Association Find Itself?" and "What Is Wrong with the American Water-Works Association?"

Is it surprising that we have not found ourselves amid the world-wide chaos of changing customs, ideals, morals and beliefs? Would it be well if we rested complacently in the belief that we had found ourselves? Is it not better never to find ourselves and to hold the illusive goal of perfection ever before us as an incentive to greater and better accomplishment? Our Association has not been unaffected by the spirit of change which is rampant everywhere. This convention is fraught with the significance of change.

I well remember the convention of 1901 at the Murray Hill Hotel in this city. The meeting room was little larger than the room used for your Executive Committee at this convention. This small room was not more than half filled by those in attendance to listen to the papers. The membership could be found in the cafe at any time of the day or night in a more or less stimulated state of exhilaration. The exhibits were insignificant and typical of that lack of the application of scientific study to water-works details which was apparent for so long. The individual evidenced an almost complete absence of the sense of personal responsibility to the association. Compare that with the present and we have a vivid picture of change in ideals and aspirations as well as of the progress which we have made toward finding ourselves. From a mere handful of men we have developed a regiment of soldiers. From an obscure, heterogeneous body we have produced a recognized, stable and respected association. I think we are criticized too often for our past, and there is a common tendency to misinterpret our present aims, to stress our externals and to overlook our true spirit.

But what is wrong with us? The failure of this association is not more conspicuous than that of other organizations or societies, and springs from the same cause. It does not meet the individual need, and the individual is not called upon to do enough for it. Those familiar with the work of our engineering societies have agreed that the original aims of these organizations are not completely satisfying at present. It is not sufficient to organize, hold conventions, elect officers, read papers and publish proceedings. All of these things are necessary, but they are not adequate. The instruction of the individual is not sufficient. Something must be done to help him in a more material sense. If this is true of the strictly engineering societies, it is more so with regard to this association. Broadly speaking, we are a technical society, but one of the chief aims of this association is to benefit the superintendent. The greatest benefit which we can render to the superintendent is to assist him toward honest endeavor, efficiency and capability in his office; to stand behind the intelligent, sober and industrious water-works man. Our greatest care should be that his badge is a certificate of character, responsibility, efficiency and power. The plan will naturally entail more difficulty than the present method of allowing every member to shift for himself. If, however, the individual felt the strength of the association behind him he would be a better official to the everlasting benefit of the community he serves.

It has been stated in the articles referred to that the prospect of a junket is more alluring to the average member of this association than the opportunity to add to his knowledge of the water-works business. We are accused of being more interested in voting for the next place of holding a meeting than in anything else; that we resent the adoption of businesslike methods of electing officers because we fear that by the adoption of such methods we are losing some of our vested rights; that there is a strong tendency toward the formation of cliques and factions; that the operating men resent the active part taken in the management of the association's affairs by technically trained men, and that there is an over-ambitious attempt at expansion.

I wish at this time to make public denial of some of these charges.

I do not believe it is true that the prospect of a junket is more alluring to the average member than is the opportunity to add to his knowledge of the water-works business. I know of no convention where more earnestness is displayed, and where the business sessions are more generally and conscientiously attended than are those of this association.

Nor do I believe that we are more interested in voting for the next place of meeting than in anything else. The session at which the next meeting place is selected is the only one which brings all classes of members together, and there is a natural rivalry between the friends of this place or that, which of itself portrays an excess of interest which is more apparent than real. There are certain features of this session which furnish a little variation to the humdrum round of technical papers and consequently there is a general relaxation on the part of all.

In this connection, however, I do not believe that the function of the Committee on the Selection of the Next Place of Meeting, which has been in existence for the past few years, has been understood. It was not the idea that this committee should select a place of meeting, nor appropriate any of the functions of the voting membership, but that it should report its findings to the convention so that it might make an intelligent choice between the invitations extended and not be governed solely by the spellbinding efforts of some orator who is given the privilege of the floor.

*Portions of the presidential address before the American Water-Works Association, New York City, June 6, 1916.

†Consulting Engineer, 100 William St., New York City.

I believe that every member of this association recognizes that the motives which should govern the selection of a meeting place are: 1. Consideration of the growth and development of the association which will be brought about by the selection. 2. The educational benefit which will be derived from the selection. 3. The facilities which will be offered for the proper transaction of the business of the convention and the comfort and happiness of those who attend. 4. Last and least, consideration of the amusement features which will be offered to those who attend.

The appointment of this committee was solely for the purpose of having representatives of the voting body calmly and judiciously to weigh the merits of the invitations offered, to crystallize the facts, and suggest which of the invitations most nearly fulfilled these requirements.

Neither do I feel that our members resent more businesslike methods in choosing officers, but rather that there is an honest dread, which is inherent in every American, lest this association become undemocratic in its administration and that its powers be usurped by a few individuals who will use it for their own specific purposes. The entire discussion of the proposed change in method of electing officers at the Cincinnati convention indicates this, and I, for one, do not feel that the democratic spirit is one which will in the long run work any injury to the association.

While there may be some who honestly believe that officers should be nominated on the floor of the convention and chosen in the old-fashioned way, I believe that the majority appreciate that the business of an organization of fifteen hundred men cannot be conducted in the same way that an organization of three hundred would handle its affairs, and in order to expedite the work of the convention it is necessary to delegate some of the powers of the individual to representatives chosen in a fair, open and democratic way. The mode of electing officers in 1890 is not adapted to the needs of 1916. To revert to the method of electing officers on the floor of the convention will not in any way lessen political activity or the desire for selfish gains if such motives are present in our ranks.

I regret to say I must admit there is some justice in the charge that there is a tendency on the part of some to separate the membership into classes, which tends to the formation of cliques and factions, but in this we are no different from other organizations. It is, however, most unfortunate for this association that the question of the profession or occupation of the member should be referred to in connection with his appointment for office.

As I see it, this association is composed of three coordinate branches: 1. The engineer and technical man. 2. The water-works superintendent, who may or may not be a technically trained engineer. 3. The manufacturer. Of these, the first two form the active voting membership and are eligible as officers of the association, and the third composes the associate membership. Each of these divisions is capable of performing a service for the association. The engineer brings to the water-works superintendent the result of his highly specialized experience. The water-works superintendent gives to the engineer the benefit of his practical experience in the application of the technical advice of the engineer. The manufacturer demonstrates to both the latest development in those devices and appliances which are useful alike to the engineer and to the superintendent. There is no reason for conflict more than there is reason for conflict between an army and navy enlisted in the common cause of defending their country. The three branches of this association are coördinate. They should be coöperative and not antagonistic. The development of the narrow spirit which invokes antagonism between the three coördinate branches is a parasite which, unless immediately choked, will sap the very life blood of the parent upon which it preys. The future of this association will be hampered if such a spirit continues.

Finally, I disagree with the statement that the complete nationalization of this association is beyond the realms of possibility. I do not believe that we can be over-ambitious in our attempts at expansion. I should like to see every worthy water-works man in the United States enrolled as a member of this association. The only way in which the mass of those who are in charge of the smaller works in this country may be reached is through the formation of local sections. Sectionalization brings added burdens, I admit, but I believe that we should accept these burdens in the name of service, manfully shoulder them, and solve the problems antecedent to complete nationalization.

The issue of a single, country-wide association was raised by my predecessor, and everyone who has a disinterested regard for the welfare of the water-works fraternity should weigh its merits and disadvantages carefully. There is much to be said in favor of a single association. It would cut the cost and time required in attending conventions in half. It would lessen individual expenses for dues. It would minimize the cost of publications. It would facilitate the classification of our technical literature. It would reduce the demands upon the time of those who prepare technical papers. It would coördinate committee work and standardize specifications. It is fair to assume that one large national organization would wield a stronger influence in moulding public opinion than would several smaller bodies. A national water-works association has a great opportunity to direct public opinion in proper channels when legislatures are about to enact laws which vitally affect such matters as stream pollution, the powers of state boards of health, the purity of drinking water, and the protection of watersheds. It could educate the public upon the necessity of placing costly water plants in the hands of skilled and qualified men without regard for the political affiliations. It could, as suggested, aid and abet worthy members in resisting the influences which all municipal employees realize are at work to reduce the efficiency which they are striving to attain.

When a national association is mentioned, some say that its size will destroy the intimate personal relation which has been one of the most valuable assets of the smaller organizations. It is at this point that the sections become useful. It must be remembered that under our present system the larger organization is composed of smaller units, each holding its own meetings at regular intervals. These sections offer an adequate means for close contact among members and insure acquaintanceship for the member who attends the national convention.

Sooner or later the question of one national association must be definitely decided. There is ample time for

thought in the interim, but provincial barriers and petty ambitions must be cast aside and the outcome must be founded upon a broad-minded view of the whole situation considered alone from the viewpoint of the greatest good to the water-works profession and from the standpoint of service to the country at large.

Preparedness is the order of the day, and we must be ready to meet the question of nationalization when it becomes an active issue, as it surely will. We will not find ourselves until we decide whether we are to be a great national organization or a narrow association developed through narrow considerations and a narrow attitude toward our fellow members. We must make this body as strong as its convictions. It matters little what our ideals may be and what achievements we may hope for if these ideals and achievements cannot be reduced to action. The events of the past and the events of the day show that ideals amount to nothing if we lack the power to maintain them against opposition.

It is pertinent to ask at this point: What should be the ideal of this association? My answer is, Service. Service of the individual to the association. Service by the association to the individual and to the country at large.

What is needed primarily is individual service, as the corporate service of the association is nothing more than the composite service of the individual. What we need, therefore, is servants, irrespective of calling or profession, servants who are willing to do and to help achieve the best results for the association. Servants who are simple, honest men, with a fellowship of interest, an *esprit de corps,* and a decided discipline; men who are interested in the actual work they are doing, for whom work itself is in a measure its own reward, in whom the instincts of workmanship, of control over brute things, the desire for order, the satisfaction of service rendered and uses created, and the civilizing passions are given a chance to temper the primal desire to have, to hold, and to conquer.

Must Give Pure Water Before Earning Fair Return

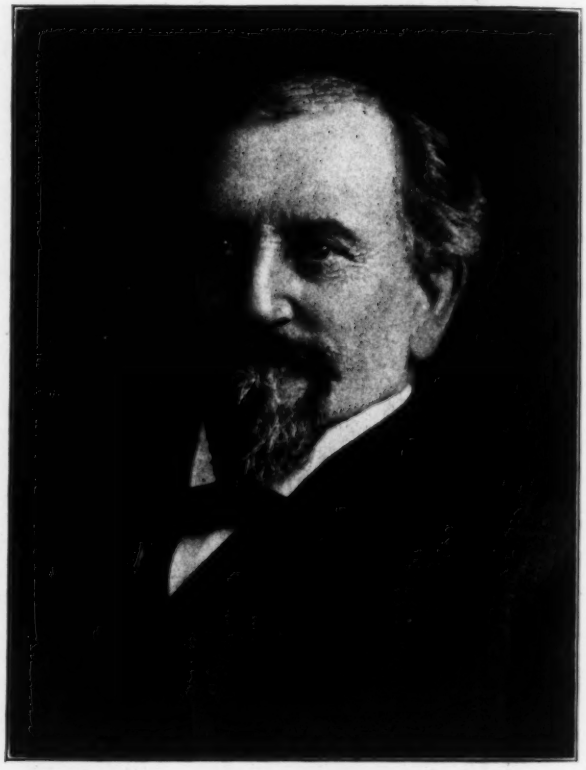
A water utility must give an adequate supply of pure and wholesome water, even though its revenues are insufficient for the purpose, is the recent ruling of the West Virginia Public Service Commission in the case of the Montgomery Light and Water Improvement Co. (Case No. 421; Pub. Util. Rep. 1916 C 406.) It was held that this company, being in the business of supplying water to the inhabitants of Montgomery and in collecting revenue therefrom, could not escape the obligation of furnishing a pure and wholesome supply and could not be heard to say that its revenue was not sufficient. The commission stated, however, that once a pure supply had been furnished it would permit rates securing adequate revenue. Separate proceedings then will presumably be required to establish the inadequacy of the earnings.

A schedule of meter rates was worked out, but ordered suspended until the better supply was given. For these rates a return of 7% on a plant value of $23,000 was allowed. For depreciation-compensation on the poorly constructed plant 5% per annum was allowed. Wages and expenses were set at $5,000, making the total necessary revenue $7,760. It was estimated that a step scale, as follows, would give this return:

Minimum, with consumption of 1,500 gal.	
Next 1,500 gal. (per 1,000 gal.)	
Next 2,000 gal. (per 1,000 gal.)	
Next 5,000 gal. (per 1,000 gal.)	
Next 5,000 gal. (per 1,000 gal.)	
Next 5,000 gal. (per 1,000 gal.)	
Next 10,000 gal. (per 1,000 gal.)	
Next 20,000 gal. (per 1,000 gal.)	

Henry Rohwer

Henry Rohwer, M. Am. Soc. C. E., an engineer widely known in the West in connection with railroad construction, died at his home in St. Louis, Mo., on May 4, at 68 years of age. He was born in Holstein, Germany,



HENRY ROHWER

Mar. 17, 1848, and was a graduate of the Jessen Polytechnic Institute at Hamburg and the Royal Polytechnic School at Hanover. Following his graduation from the latter, in 1869, Mr. Rohwer came to the United States, and was immediately engaged on the construction of the Burlington & Missouri River R.R. lines in Nebraska, serving in various capacities from topographer to chief engineer of that railroad.

In 1875 he entered into private practice as a consulting engineer and architect in Omaha, Neb., of which city he was appointed city engineer in 1877. In 1881 he left the service of the city to become engineer in charge of location and construction of the Oregon Short Line, including Hodges Pass Tunnel, and in 1884 resumed his consulting practice in Omaha, which he continued for about a year.

From 1885 to 1887 he was engineer in charge of location and construction of the Omaha Belt Ry. and the Missouri Pacific extension to Lincoln, Neb., and from

1887 to 1901 was engineer of maintenance-of-way of the Missouri Pacific System and its branches. In 1901 he was appointed chief engineer of the Missouri Pacific and the St. Louis, Iron Mountain & Southern Ry., which position he held until 1905, when he resigned to take up consulting engineering in St. Louis, Mo.

During the past ten years Mr. Rohwer had made many important investigations and reports on railroads, waterworks, power plants, etc., both in the United States and in Canada. He was employed by the City of St. Louis, and made a report on the "Selection of Site for Municipal Free Bridge" in 1907. It has been said that he superintended the construction of more miles of railroad than any other engineer in the United States. He was in charge of the construction of a $4,000,000 railway enterprise in Georgia at the time of his death.

Baltimore Experiments on Grease from Sewage

Experiments to determine the amount of grease in the sewage of Baltimore, Md., and the percentage of the grease which was saponifiable and non-saponifiable were made in 1915 during a period of two and a half months, at the Back River sewage-disposal plant of that city. The following concise account of the nature of the experiments has been supplied to *Engineering News* by Calvin W. Hendrick, Chief Engineer of Baltimore:

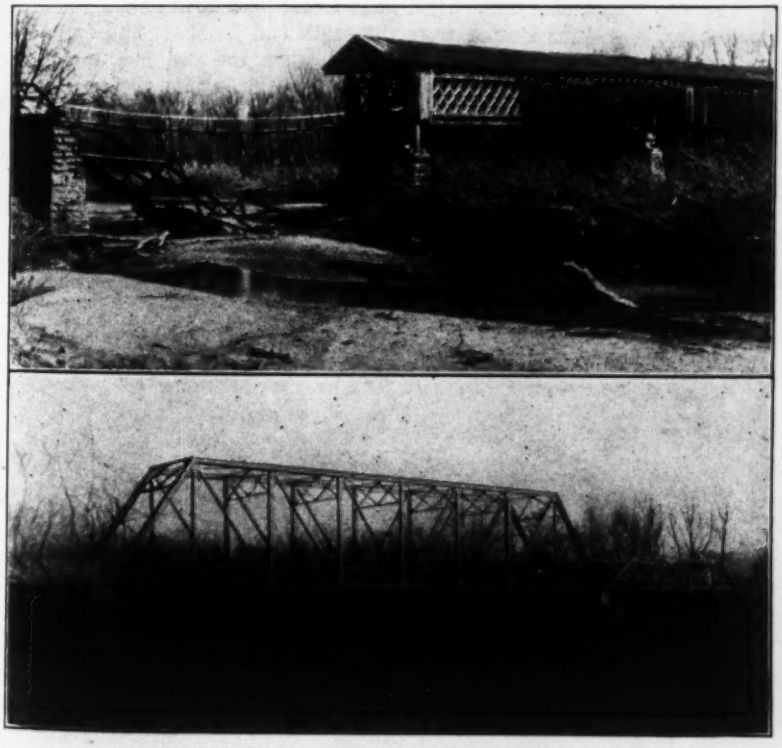
A circular tank was supplied with raw sewage by a pump, the suction pipe of which was led into a long box having a slot cut in the side extending from the surface to a point 4 ft. below the surface. The pump discharged into a constant-head weir box which was used to control the flow. The sewage flowed from the weir box into a lead funnel into which was also fed the sulphuric acid. A lead pipe led from the funnel to the tank and entered at a point 1 ft. from the bottom. The inside end of this pipe was bent laterally to impart a slow circular motion to the sewage. The acidified sewage was drawn off at the top through a weir with a baffle in front of it. The flow was regulated to give a retention period of five hours.

During the time the experiment ran 24 cu.ft. of sludge accumulated, which was found to contain 27.5% grease on a dry basis. Of this 27.5%, 86.34% was saponifiable and 13.66% non-saponifiable grease. The sludge obtained had a very offensive odor and contained 93.9% moisture. It was very hard to dry on a sand bed; in fact, after 48 days in summer weather it still retained 66.8% moisture.

An account of grease removal experiments at Boston, Mass., was printed in *Engineering News* of May 11, 1916, p. 813, and some comment on these other experiments in grease removal appeared May 25, on p. 1005.

An Old Timber Bridge and Its Modern Successor

An old-time timber-truss highway bridge over the Spoon River in Bernadotte township, Fulton County, Illinois, has given place to a modern structure that includes both steel and reinforced-concrete spans. The accompanying views show the old bridge after a partial washout and also the new bridge, which was opened to traffic in January, 1916. Information has been furnished by G. F. Burch, Assistant Bridge Engineer, Illinois State Highway Department, Springfield, Ill.



OLD TIMBER BRIDGE AND ITS SUCCESSOR

Upper view shows old two-span timber truss and washed-out steel span. Lower view shows new structure with two steel truss spans and concrete girder span

The old structure consisted of a timber truss, with two spans of 80 ft. and 76½ ft. c. to c. of piers, and a 24-ft. roadway. The trusses, the stone piers and abutments were built in 1845. The remainder of the bridge consisted of two steel-truss spans of 76½ ft. and 32 ft. with 20-ft. roadway. These were built in 1895. In the spring of 1915 the bridge was damaged by flood, as shown in the upper view. It was decided to reconstruct the bridge at the joint expense of the state and county. The stone piers and abutments were found to be generally in good condition and it was decided to retain them in the construction of the new bridge, which consists of a 30-ft. reinforced-concrete through girder span, a 155½-ft. steel span and a 75-ft. steel span, all having an 18-ft. roadway. One of the old piers (shown in the center of the upper view) was found to be in poor condition and was removed. This resulted in a longer span over the main channel. The old stone piers and abutments were pointed up and capped with concrete to bring them to the proper elevation to support the shoes of the new structure.

News of the Engineering World

Pittsburgh May Have Transit Commissioner

The Public Service Committee of the Pittsburgh City Council has prepared an ordinance enabling the mayor to appoint, with the approval of the Council, a commissioner to report on a rapid-transit system. This action followed renewed local agitation for rapid transit culminating in a preliminary survey gratuitously made by A. M. Taylor, late transit commissioner of Philadelphia.

The encumbent of the new office, in case the Committee's ordinance is passed by the Council, will be selected after a conference of the councilmen, mayor, city law department, and the Engineer's Society of Western Pennsylvania.

"Personal Safety First" Aids Albany Collision

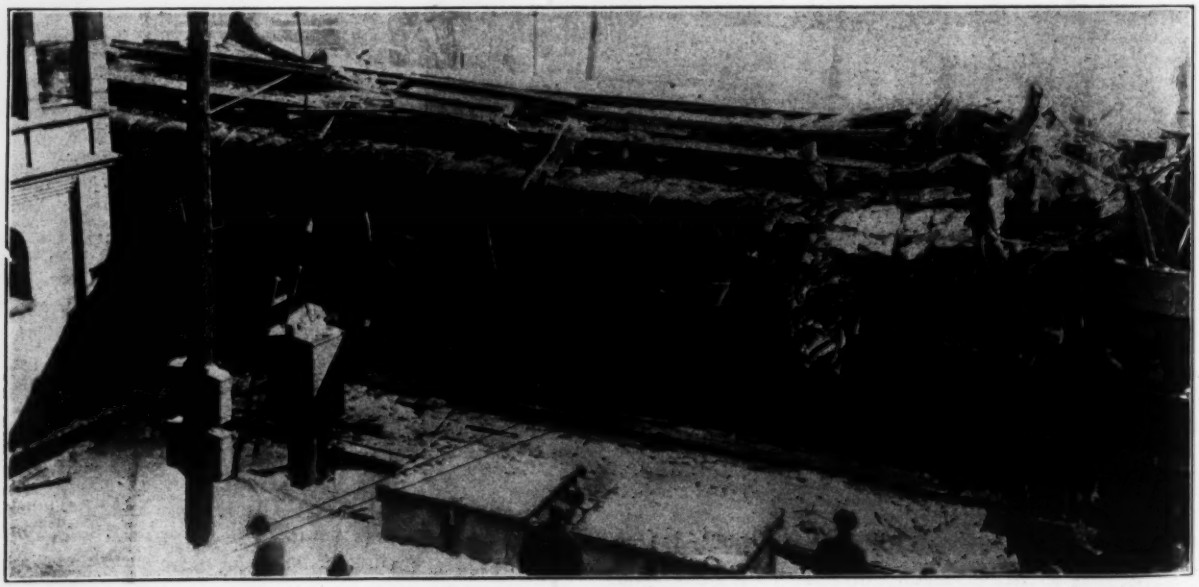
The Coroner's report of the rear-end collision between a New York Central coal train and a train made up of express cars on the Broadway viaduct, Albany, N. Y., on Mar. 3, states that if the brakes of the freight had been set properly in descending the hill to the viaduct, the accident would not have occurred. The report states further that from the evidence of the crew of the freight train the brakemen were practically green men, and the engineman's cab experience dated only from Dec. 25, 1915. The engineman lost control of the brakes and perceiving that a collision was imminent he jumped.

Personal-safety first seems to have been the underlying cause of the collision, together with too big a train to be handled by other than a veteran railroader. It is the opinion of many old railroad men that 50 cars is about the limit to which the emergency brakes will be effective unless the retaining valves are set to hold air back of the brake pistons. On the freight which ran into the express-car train there were 98 cars, and it would probably have taken the brakemen ten minutes to cover the train and set the retainers at every fifth or tenth car, which is the ordinary practice.

On the rear of the express train were two day passenger coaches, one of steel and the other of wood with steel underframe. In the collision these two coaches telescoped, as illustrated in the view.

Marseilles-Rhone Canal Not Yet Finished

Evidently there was an error in the announcement of the opening of the Marseilles-Rhône canal tunnel which was recently widely circulated in the American press following dispatches from France, and which was noted on page 917 of *Engineering News*, May 11, 1916. From a recent article in *Le Genie Civil* it appears that one of the two advance headings was holed through on Feb. 18, 1916, and that the celebration which took place on May 7 was in honor of that event. This heading is about 80 sq.ft. in cross-section, whereas the whole tunnel is about 3,060 sq.ft. in section. The work on the headings was started from the south end in 1911, and from the north end in 1914, and when the two met the south heading had advanced 15,446 ft. while the north had advanced 8,392 ft., the tunnel being over 5 mi. long.



WHAT A STEEL CAR DOES TO A WOODEN ONE WHEN IT TELESCOPES IT

While the work is still going on, the progress of late has necessarily been retarded by the war. With the aid of war prisoners, however, the contractor is able to make some headway and it is stated that the project will be completed some time in 1919.

Memphis To Have $1,500,000 City Electric Plant

F. W. Ballard, the representative of the City of Memphis, Tenn., in the appraisal of the Merchants Power Company's plant, has reported to the Board of Commissioners that efforts to select a third arbitrator have proven unavailing, and he has recommended that the city proceed with the construction of a plant, as provided by the terms of a recent $1,500,000 bond issue. He reported that the city could sell current at 5c. per kw.-hr. and that it is probable that production cost will be 3c.

The State Supreme Court recently handed down a decision sustaining the validity of these bonds, which were contested on various technical grounds.

Higher Court Affirms Decision Against Thacher Patent

The Federal Court of Appeals for the Second Circuit, Judges Cox, Ward and Chatfield sitting, on June 7 affirmed the decision of Judge Thomas of Jan. 8, 1916, in favor of the Transit Construction Co., which had been sued by Edwin Thacher for infringement of his United States Patent No. 617,615 "for new and useful improvements in concrete arches." As noted in *Engineering News*, Mar. 23, 1916, p. 580, the lower court decision hinged on the question of the independence of the upper and lower rods in the reinforcement of the arch. The decision virtually holds that the essential feature of the Thacher patent is the independence of these two planes of rods and any arch in which there is a direct and substantial connection between the two can not be claimed as an infringement of the patent.

ENGINEERING SCHOOLS

University of California

The College of Chemistry has established a new four-year course in chemical engineering.

The College of Mining has reorganized its curriculum so that hereafter students may with the beginning of the sophomore year elect professional training in mining engineering, metallurgy, economic geology or petroleum engineering. Two new courses will be added next year to the instruction for oil engineers. One will be a course on petroleum cost accounting and the other a course in which will be taken up special technical problems connected with the production and transportation of oil.

University of Wisconsin

An exhibit of mechanical fittings and valves has been given to the College of Engineering by the Crane Co., Chicago, for demonstration purposes. It will be used for exhibition to the students in the electrical, chemical and mechanical departments. The display has been temporarily placed in the gallery of the steam laboratory and will be open to inspection by the public. About 85 pieces are included in the collection. The larger pieces are mounted on nickel-plated cast-iron pedestals with the upper part swung on ball bearings. They are all quarter-sectioned, to show the inside. Most of the smaller pieces are sectioned and mounted on nickel-plated mountings, and are exhibited in a stand with plate glass front. Purdue University, the only engineering school in the country which possesses a collection equal to it, received its exhibit from the same company.

NOTES

Reinforced-Concrete Piers on the ocean pier at Ocean Park, Calif., were not harmed in a recent fire which destroyed the wooden superstructure. Although the concrete was subjected to intense heat it is still in sufficiently good shape so that the piers can be used in the reconstruction without patching.

A Demonstration of Fire-Retardant Treatment for wood was made at the Forest Products Laboratory at Madison, Wis., during a visit of the National Lumber Manufacturers' Association. Two small houses, one of treated wood, the other of plain wood, were subjected to a high-heat exposure, and the untreated house burned while the other merely charred.

The Austin Dam, across the Colorado River at Austin, Tex., is once more under investigation. Bartlett & Ransey, consulting engineers, with offices at San Antonio and at Dallas, Tex., have been engaged by the City of Austin to make a thorough inspection of the dam. The present investigation is for the purpose of comparing the structure with what it would have been, if built as originally designed, together with a report upon the comparative cost and stability.

The Semaphore System of Regulating Street Traffic will not be used in Boston, although the street commissioners believe that it would help relieve congestion in the down-town streets, basing their opinion on the success of a fixed semaphore which was tried out at the corner of Tremont and Winter St. Their decision is the result of a letter from Police Commissioner O'Meara to the effect that he believes that semaphores would delay rather than expedite traffic, and that he would not authorize his men to operate them.

A Movement To Organize an Engineers Union in Australia appears to have met with little success. The "Commonwealth Engineer" of May 1 publishes a letter, the writer of which declares that many professional engineers in Australia are earning only 12½ to 15 shillings per day, while foremen and first-class trade union men earn 17 to 20 shillings per day, and he urges the organization of an engineers labor union. In connection with the publication of the letter, however, it is stated that a proposal to form an engineers union was brought before the Registrar of the Queensland Arbitration Court, and the application was refused.

Railway-Valuation Work has been in active progress on the Cleveland, Cincinnati, Chicago & St. Louis Ry. During last summer and fall there were engaged in this work four track and roadway parties, two terminal roadway parties, two bridge parties, a signal party, two building parties, a telegraph party and several mechanical parties. The work of taking the inventory was completed in 1915, except for the buildings on about 300 mi. of line. Since then the company's engineering forces have been engaged in perfecting new maps and profiles and making a check on the inventory notes made by the Interstate Commerce Commission.

A Contract for Pavement and Sewer Construction in Havana, Cuba, held by the McGivney & Rokeby Construction Co. of New York City, has been abandoned by the contractors, according to a cable dispatch from Havana to the New York "Times," dated May 29. The contract involved work amounting to some $15,000,000. For nearly a year past investigations have been in progress which have revealed serious defects in the portions of the work completed. The government ordered the contractors to repave many streets where faulty work had been done. Instead of doing this the company decided to abandon the contract and forfeit its bond for $500,000.

Two Thousand Three Hundred Engineers Marched in the "Preparedness Parade" at Chicago on June 3. They were not grouped as members of the various technical societies represented, but marched together simply as a body of engineers. At the head of the division was a company of young

men in field costume carrying transit, levels and rods. The entire parade numbered about 130,000 persons, according to official count. This count was made by two sets of four men each. Each set consisted of two counters and two men with adding machines, the pairs working half-hour shifts alternately. One set counted the total number of persons. The other set counted the number in each division.

A Contract for 700,000 Gal. of Asphaltic Road Oil has been awarded by the Tennessee Department of Highways to Sam E. Finley, of Atlanta, Ga., at an average price of 4.89c. per gal. The larger part of this oil will be used on macadam roads in five counties as follows: Davidson (Nashville), 170,000 gal.; Hamilton (Chattanooga), 100,000; Knox (Knoxville), 100,000; Shelby (Memphis), 200,000; Madison (Jackson), 20,000. The remainder of the oil is to be used in various towns. The state pays for the oil from the proceeds of the automobile tax, the money being returned to the counties in which the tax was collected. The various counties have already bought pressure distributors for applying the oil. A. M. Nelson, Nashville, Tenn., is State Highway Engineer.

Another Reinforced-Concrete Pier is to be built at Baltimore, Md. The Pennsylvania R.R. has one under construction, as recently noted in "Engineering News," and now the Canton Co. is about to build a new structure at Canton, Md., to handle ores incoming from Cuba and Chile. The structure is designed by the Cleveland Dock Engineering Co., Cleveland, Ohio. It consists of a pier 77 ft. long and 600 ft. wide with a side dock wall continuing back on one side for 400 ft. longer, making a 1,000-ft. dock on that side. It will have a reinforced-concrete ribbed floor supported on piles, with marginal end buttresses to retain earth fill. It will carry four railroad tracks and ore-handling gantries. Sanford & Brooks, Baltimore, Md., have the contract for the construction, and the Mead-Morrison Co., of Boston and Chicago, for the ore-handling equipment.

The Vote to Abandon Commission Government at Denver, Colo., two weeks ago will probably have little direct effect upon the management of the public works of that city. The vote was on an amendment to the city charter which provided for a return to the mayor-and-council plan in place of the commission plan. The new mayor has named as city engineer J. B. Hunter, for many years city engineer and latterly commissioner of public improvements. There will be added to Mr. Hunter's duties that of the control of city parks, thus placing in his hands practically everything in the line of public works and city property. The project for municipal ownership of water-works will remain in the hands of the Public Utilities Commission until May 31, 1918. This commission, under the terms of its creation, has now diminished in numbers to a single member, Armour C. Anderson.

Los Angeles Voted No on several bond issues, a new city charter and various alternative charter amendments and other questions on June 6 and voted Yes on the annexation of more territory. The defeated bond issues were $8,000,000 for a municipal telephone system; $1,800,000 for sewage disposal, including treatment works at Hyperion and Los Angeles Harbor; $1,250,000 for fire houses and apparatus; and $300,000 for the Second-Street Tunnel. Proposals to sell Los Angeles Aqueduct water outside the city, instead of adhering to the principle of no city water without annexation, were defeated. The two new tracts to be annexed to the city are known as Westgate, 30,000 acres on and near the coast between Santa Monica and the recently annexed San Fernando district, and Occidental, a much smaller area. Each of these areas voted for annexation by a large majority at an earlier election.

The $2,940,000 Water-Conservation Project at Fall River, Mass., recommended in a report submitted to the City Council in September, 1915, by the Watuppa Ponds and Quequechan River Commission, will not be carried out for the present. The commission has been suspended for the time being and a new board is to be appointed to make further study of the matter. The new commission will consist of three members, one selected by the riparian owners along the Quequechan River, one by the Watuppa Reservoir Co., and a third by the Mayor of Fall River. The project recommended last September ("Engineering News," Oct. 14, 1915, p. 760) provided for four conduits in a single three-story reinforced-concrete structure. These conduits were designed to convey lake water for power, to divert sewage, to turn surface water at will into a pond for storage or into a river to waste, and to convey condenser water into oil-separating and condenser basins. The project, if carried out, would regulate water power for mills, increase the water-supply of the city, abate river pollution nuisance, and reclaim 146 acres of land. Allowing for benefits, the net cost of the project was estimated at $1,000,000. Many citizens of Fall River considered this too high a cost.

Information on the Use of Water Meters is wanted by the Committee on Meter Rates of the New England Water Works Association. The chairman of the committee is Allen Hazen, 30 E. 42nd St., New York City. Reports are desired for works which are completely metered or nearly so. The information sought includes total quantity of water supplied; how measured and slip allowed; quantity of water recorded by meters or accurately estimated; total quantity of water accounted for; whether services and meters are paid for by works or by customer. In addition there is desired a tabular statement of the number of services, the quantity of water used and amount of water charged for under eight groups of quantities in cubic feet per quarter, beginning with over 3,000,000 cu.ft. and ending in under 1,000. If the records are not kept by quarterly periods, any other period for which figures can be given will do. The committee is primarily interested in three classifications, namely: Less than 10,000 cu.ft. per quarter; between 10,000 and 100,000 cu.ft.; and more than 100,000 cu.ft. per quarter. The ranges of quantities just stated are those which were recommended some time ago by the committee as the basis for a three-class meter system—domestic, intermediate, and manufacturing. The association did not adopt the committee's recommendation for meter rates so based, but instead referred the matter of rates back to the committee for further investigation.

The Chiriqui National R.R. was completed and officially inaugurated for public service, Apr. 22 to 25, by the president of the Republic of Panama, the cabinet and about 100 invited guests from the Cities of Panama and Colon. The railroad extends from the port of Pedregal on the Pacific side of the republic, passing through the City of David and terminating at El Boquete, 3,660 ft. above sea level. Branches to La Concepcion and Potrerillos bring the total trackage to 60 mi. The railroad is notable in the respect that to reach Boquete 10 mi. of 4½ to 5% continuous grade is resorted to. Many sections are of heavy mountain work. The standard of construction has been high-grade throughout—56- and 70-lb. rails are laid on creosoted ties and native hardwood ties. The entire line is ballasted with crushed rock and gravel. All large drainage openings are steel bridges resting on concrete piers and abutments. For the smaller openings corrugated-iron culverts were installed. The motive power consists of Consolidation type 2-8-0 locomotives with 60 tons on drivers. These locomotives are capable of hauling 125 tons at 10 mi. per hr. on the maximum grade of 5%. The studies for the railroads were made by R. W. Hebard & Co., Inc., of 16 Exchange Place, New York City, in 1913, and the same firm undertook the complete construction and equipment of the railroad ready to operate in April, 1916, their contract with the Government of Panama calling for completion by May 1, 1916. A. S. Zinn was consulting engineer for the Government of Panama. The railroad was placed in commercial operation on Apr. 30, R. W. Hebard & Co., Inc., assuming temporarily the management of the property.

PERSONALS

Warren D. Spengler has resigned from the Cleveland Construction Co. to become Construction Engineer for the Goodyear Tire and Rubber Co.'s new building at Toronto, Ont.

W. F. Dozier, who has been employed by the City of Taylor, Tex., on paving work for a year past, has been appointed City Manager, under the new form of government, at a salary of $2,600 a year.

Francis C. Shenehon, M. Am. Soc. C. E., has tendered his resignation as Dean of the College of Engineering, University of Minnesota, to take effect May 1, 1917. Dean Shenehon will open offices for private practice.

C. F. Hamilton, M. Am. Soc. C. E., formerly General Manager of the Northwestern Construction Co., Franklin, Penn., is now engaged in business under the firm name of C. F. Hamilton, Inc., as Construction Engineer and Contractor, with offices in the Franklin Trust Company Building, Franklin.

G. R. Delamater has been made Fuel Engineer for the Steelton, Penn., plant of the Pennsylvania Steel Co., recently acquired by the Bethlehem Steel Co. He will have charge of coal washing, supervision of the coal stock, including coking, bituminous, gas, slack and anthracite coal, coke breeze and miscellaneous matters between the various operating departments and the Semet-Solvay Co.

H. R. Trumbower, of the Department of Political Economy of the University of Wisconsin, has been appointed a Member of the State Railroad Commission to serve during the remainder of the term of Halford Erickson, who recently resigned.

Professor Trumbower is a graduate of Lehigh University and has studied also at Princeton and in the University of Munich, Germany. He has been teaching in the University of Wisconsin since 1910, most of his work having been in the problems of political economy studied in the Course in Commerce and the College of Engineering.

OBITUARY

Sydney A. Butler, who was engineer during the construction of the Denver & Rio Grande R.R. line through the Grand Cañon of the Arkansas, died at Los Angeles, Calif., on June 4. He was 69 years old.

Sir Hay Frederick Donaldson, who perished with Lord Kitchener in the sinking of H. M. S. "Hampshire," June 5, was a prominent engineer. He was a member of the Institution of Civil Engineers and a past-president of the Institution of Mechanical Engineers. He was born in 1856 and was the son of Sir Stuart Donaldson, first Premier of New South Wales.

Lord Horatio Herbert Kitchener, Secretary of War of Great Britain, who with his staff was drowned in the sinking of H. M. S. "Hampshire," off the West Orkney Islands, on the night of June 5, was a graduate of the Royal Military Academy at Woolwich and entered the Royal Engineers in 1871. Between 1874 and 1882 he had charge of extensive survey work in Palestine and the Island of Cyprus. For several years he was head of the Royal Engineers. He had been an honorary member of the Institution of Civil Engineers since 1904.

Chester Bidwell Albree, M. Am. Soc. M. E., President of the Chester B. Albree Iron Works, died at his home in Pittsburgh, on June 3, at 54 years of age. Mr. Albree was born in Pittsburgh. He attended Williston Academy and Worcester Polytechnic Institute, where he received the degree of Mechanical Engineer in 1884. Mr. Albree was an inventor and manufacturer of machinery and mechanical devices, some of which are in wide use in this country. He was Past-President of the Engineers' Society of Western Pennsylvania.

James H. McClure, an old and well-known railway and bridge contractor in the Northwest, died at his home in St. Paul, Minn., on June 5. Mr. McClure is said to have built the first bridge across the Mississippi River at Anoka, Minn. For many years he was one of the contractors on the Chicago, St. Paul, Minneapolis & Omaha Ry., putting up a number of bridges and having charge of the double-tracking of the road from St. Paul to Chicago. Since his retirement, about four years ago, the James McClure Construction Co. has been managed by his son, John H. McClure. Mr. McClure was 74 years old and had lived in St. Paul 40 years.

Anson Dinsmore Houghton, Mechanical Engineer, died at Santa Cruz, Calif., on June 5. Mr. Houghton was a graduate of the University of Maine and was a doctor of philosophy. Mr. Houghton went to California about 10 years ago, previous to which he was in the employ of John D. Rockefeller and was architect and builder of the Rockefeller Hall Library. He also designed the heating and electric-light plants of the University of Chicago. More recently he had been superintendent of industrial training in various schools in the Southern States under the John Slater Fund for the Advancement of Negro Education. He was 51 years of age.

ENGINEERING SOCIETIES

SOCIETY OF AUTOMOBILE ENGINEERS.
June 12-16. Summer meeting (cruise on Lake Huron and Georgian Bay). Secy., Coker F. Clarkson, 29 W. 39th St., New York City.

MASTER CAR BUILDERS' ASSOCIATION.
June 14-16. Annual meeting, Atlantic City, N. J. Secy., Jos. W. Taylor, Karpen Bldg., Chicago.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 14-17. Eighth semiannual meeting. Cleveland. Secy., I. C. Olsen, Cooper Union, New York City.

RAILWAY SUPPLY MANUFACTURERS' ASSOCIATION.
June 14-21. Convention in Atlantic City. Secy., J. D. Conway, 2136 Oliver Bldg., Pittsburgh.

SOCIETY OF RAILWAY CLUB SECRETARIES.
June 16-17. Annual meeting in Atlantic City. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN RAILWAY MASTER MECHANICS ASSOCIATION.
June 19-21. Annual meeting, Atlantic City, N. J. Secy., Jos. W. Taylor, Karpen Bldg., Chicago.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION
June 19-22. Annual meeting in Charlottesville, Va. Secy., F. L. Bishop, University of Pittsburgh, Pittsburgh.

TRI-STATE WATER AND LIGHT ASSOCIATION OF THE CAROLINAS AND GEORGIA.
June 21-23. Annual convention at Isle of Pines, S. C. Secy., W. F. Stieglitz, Columbia, S. C.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.
June 22-23. Meeting at Cleveland. Secy., Frank E. Sanborn, Ohio State University, Columbus, Ohio.

NATIONAL GAS-ENGINE ASSOCIATION.
June 27-29. Annual convention in Chicago. Secy., H. R. Brate, Lakemont, N. Y.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 27-30. Annual meeting in Pittsburgh. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 27-30. Annual meeting in Atlantic City. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

The Southwestern Electrical and Gas Association at its 1916 convention elected the following officers: President, F. R. Slater; vice-president, H. C. Morris, and secretary, H. S. Cooper.

The Pacific Northwest Society of Engineers will hold its convention and dinner in the third week of June. The principal address at this meeting will be on the subject of the "Cedar River Reservoir Problem" and the extension of the water-supply of Seattle. The last regular meeting was held on May 31, the subject being the "Test of Concrete Floor Slabs."

The American Institute of Chemical Engineers will hold its eighth semi-annual meeting June 14 to 17, in Cleveland, with headquarters at the Hotel Statler. The usual excellent list of excursions has been arranged to the important industries of Cleveland and vicinity. These include the ore docks of the Pennsylvania R.R., the Cleveland Filtration Plant, the works of the National Carbon Co., and the plant of the National Lamp Works. Among the papers to be presented are "The Cleveland Sewage-Disposal Plant," by R. Winslow Pratt; "The Purification of Sewage by Aëration in the Presence of Activated Sludge," by Edward Bartow, and "Water Powers of the United States," by Herman Stabler.

The American Electric Railway Manufacturers' Association has discontinued its activities for the present. Heretofore it has held an exhibit in conjunction with the October convention of the American Electric Railway Association. This year the exhibit will be handled by the latter organization.

The Electric Vehicle Association of America was recently affiliated with the National Electric Light Association, becoming the Electric Vehicle section of the latter. The section secretary is A. Jackson Marshall, 29 West 39th St., New York City. The sixth annual convention of the Electric Vehicle Association of America, was held last October in Cleveland and the seventh annual meeting would have been held this October. Instead, however, the new section convened with the National Electric Light Association at the recent convention of the latter in Chicago.

The Boston Society of Civil Engineers and the New England Water-Works Association will hold their annual field day and excursion on June 21, the usual ball game will be at Pemberton, Mass., and the dinner at the Pemberton Inn. A steamboat trip will be taken on the regular boat of the Nantasket Beach Steamboat Co. The executive committee of the New England Water-Works Association will meet in the purser's office on the steamer, at 11:30 a.m. A business meeting of the association will take place immediately after dinner.

The Engineers' Society of Pennsylvania, of Harrisburg, has inaugurated a campaign for additional members throughout the state. William B. McCaleb, Superintendent of the Philadelphia Division of the Pennsylvania R.R., is chairman of the committee which is waging a thorough canvas of Pennsylvania engineers. An effort will be made to double the membership of 700 within a month. On account of its location at Harrisburg, the Engineers' Society of Pennsylvania holds a strong position among engineers. Practically every piece of construction work in the state must be acted upon by some department at the State Capitol and this brings hundreds of engineers to the city every month.

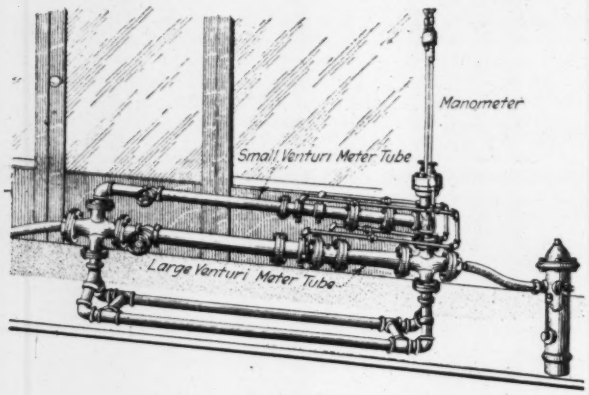
The New York Electrical Society held its annual meeting at the Hotel McAlpin, New York City, on the afternoon of June 14. The officers elected were: President, Putnam A. Bates; vice-presidents, C. E. Scribner, Edwin B. Katte, and W. C. Whiston; treasurer, Thomas F. Monahan; secretary, George H. Guy.

Appliances and Materials

Venturi-Meter Waste Detector

A portable waste detector comprising two venturi tubes and a supporting frame has been designed by the Builders' Iron Foundry, of Providence, R. I., at the instance of Hazen, Whipple and Fuller, Consulting Engineers, of New York City. The first one was made for the City of St. Johns, N. F. As shown in the accompanying sketch, it comprises two venturis of different but overlapping capacity ranges and a mercury manometer—all mounted on a pipe framework. The manometer is a barometric type with the base well connected to the inlet end of each tube and the top interior of the glass tube communicating with the throat chamber. The graduated portion of the tube is 22 in. long. The dimensions of the base of the detector are 17½x80 in. The length is 96 in. over all and the height 20 in. The gross weight is about 800 lb.

In making a leakage test, which is best done late at night when the normal flow is a minimum, the district tested is cut off from the system by the main valves. Then the waste detector is connected by hose between a hydrant outside the



VENTURI WASTE DETECTOR

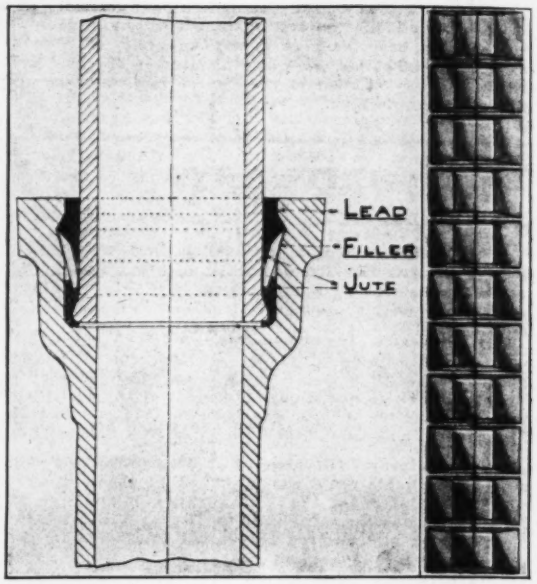
district and one inside. The meters then enable the inflow to be measured; the larger tube is tried first and if the flow is too small for good observations the smaller one is tried. By closing gates so as to make the district smaller and smaller the flow in various mains can be deduced.

* * *

Iron Filler for Lead-Pipe Joints

A patented iron filler ring has been devised by the American Cast Iron Pipe Co., of Birmingham, Ala., to save half the lead in an ordinary hub-and-spigot pipe joint. The filler is simply a string of iron wedges cast on a steel wire. In using this device a little jute is first rammed into the joint; then a string of wedges is bent around the spigot and slipped into the hub. More jute is rammed in to force the wedges over into the lead ring of the hub; finally the lead is poured and calked as usual.

It is claimed that added advantages have developed, besides the saving in lead: The lead is more easily forced up into the lead ring; the wedges force the lead into the lead ring when pressure (from water or settlement) comes on the joint, making the latter tighter; greater rigidity is secured in a pipe line but with sufficient flexibility. Tests on a loaded 4-in. joint are reported to have shown a deflection of 7½ in.



FILLER FOR CAST-IRON PIPE JOINTS

under a concentrated load of 622 lb., but without leakage under 300 lb. hydrostatic pressure. These "tightening wedges" are guaranteed by the makers to save 50% the usual quantities of lead and to give a more satisfactory joint. There are about 1,000,000 tons of cast-iron pipe used per year in this country and 40,000,000 lb. of lead; at the current price of 7½c. per lb. the saving would be $3,000,000.

* * *

New "Pulmotor" Resuscitator

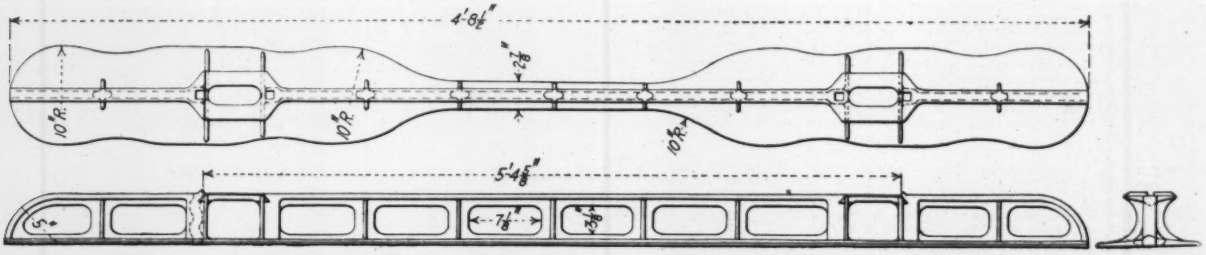
A new type of "Pulmotor" resuscitation apparatus has been devised by the Draeger Oxygen Apparatus Co., of Pittsburgh. This is designed to eliminate the objections to the older type, which had an uncertain pump control. The principal feature of the new equipment is a control valve that gives accurately measured pressures on the patient's lungs and indicates to the operator the inhalation and exhalation pressures. It is claimed that the new machine can be successfully and safely used by an unskilled operator. It weighs 12 lb., complete with carrying case, and costs $115.

* * *

Cast-Steel Crosstie Using Dog Spikes

A new type of cast-steel crosstie is being placed on the market by the Maryland Crosstie Co., 627 Munsey Building, Baltimore, Md. It is a single annealed basic-steel casting and for standard-gage railways is made with a base flange 10 in. wide at either end, but with the width decreased in the middle portion of the tie to prevent center binding or floating of the tie when supported in the center, but not on the ends. From the center of the base flange a skeleton vertical flange projects upward to a height of 5 in., and upon this are provided suitable rail seats. The rail is kept from spreading by a shoulder at the outer edge of each seat. For standard gage the tie weighs 125 lb.

On either side of the rail seat a hole is cored through the entire depth of the casting. This hole is provided with cast lugs upon either side, so that when the ordinary railroad spike is driven into the tie to hold the rail in place, the spike bends from side to side, making a reverse curve, in which shape it is held securely in place without any other fastening.



MARYLAND CAST-STEEL CROSSTIE FOR STANDARD-GAGE RAILWAY TRACK

Engineering News

Volume 75, No. 25
Issued Every Thursday
Hill Publishing Company

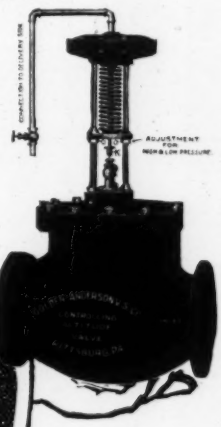
NEW YORK, JUNE 22, 1916

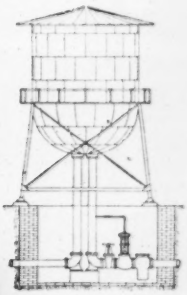
JUN 23 1916
UNIV. OF MICH.

Contents, First Page
Advertising Index, Last Page

Ah!—Here's the Real Solution

for many a vexatious problem in fire, sprinkler and other water distribution systems and a positive cure for all needless water waste down the overflow of Tanks, Standpipes and Reservoirs. Absolute dependability is the strongest feature of





Golden-Anderson

Cushioned Automatic Controlling Altitude Valves

They automatically maintain the water level constant at the desired point without the use of uncertain and cumbersome floats or fixtures of any kind within or outside of the tanks.

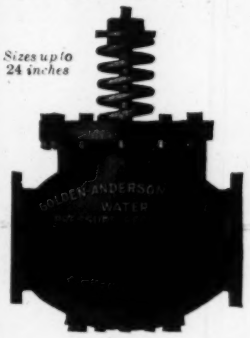
No freezing in cold climates. No water-hammer or shock. Thoroughly cushioned. Virtually indestructible.

They close automatically when the head of water to the height desired and open automatically when it drops below this mark.

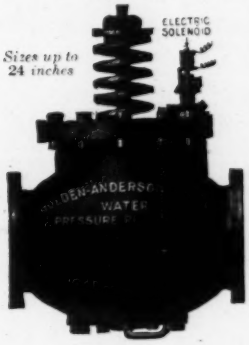
May also be arranged to close by electricity from any distant point and to automatically close when a break occurs in the mains. When necessary they may be so connected as to "work both ways" on a single line of pipe. "Hosts of References."

Valves Cushioned at all times by air and water
No water hammer or bursting mains
No metal to metal seats
Economic—Sensitive—Reliable—Virtually Indestructible

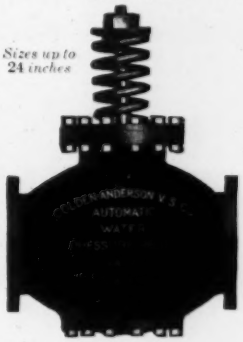
Automatic Water-Pressure Regulating Valve
Sizes up to 24 inches



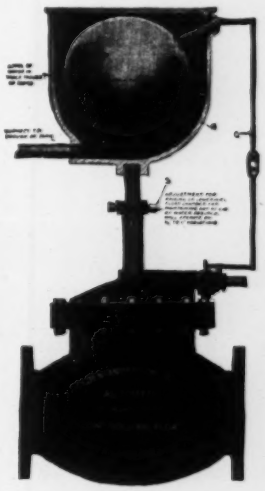
Same Valve Electrically Operated
Sizes up to 24 inches



Automatic Water Relief Valve
Sizes up to 24 inches



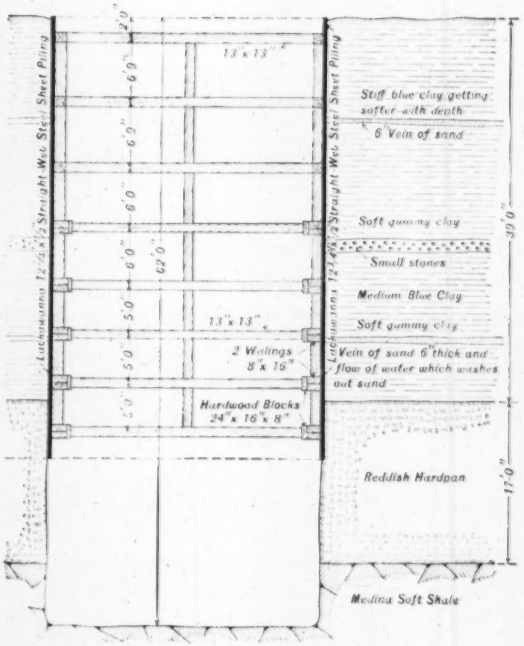
Automatic Controlling Float Valve
Sizes up to 24 inches



Golden-Anderson Valve Specialty Co.
1202 Fulton Bldg. - - - Pittsburgh, Pa.

Lackawanna Steel Sheet Piling Cofferdam In Which The Breast Wall For Lock No. 2 Of The Welland Ship Canal Was Built.

The steel sheet piling here, driven in 45-foot lengths, in accordance with the cofferdam design shown in our last week's advertisement reached refusal in hardpan at 38 feet, and was left at this position until after excavation to the bottom ends of the sheet piling sections, when the wedges between each piling section and the timber waling were knocked out from one pile at a time and the pile was driven into hardpan at 45-foot depth This was accomplished without difficulty, the wedges replaced and succeeding piles treated in the same manner, after which excavation proceeded to the bottom. An 8,000-lb. steam hammer drove about 20 of the steel sheet piling sections in a day.



The interlocked joints of the steel sheet piling became practically watertight. Although the old Welland Canal ran within 20 feet of one side of the cofferdam, water entered only under the toe of the piling wall and was easily kept down with a 5-in. pump.

The accuracy to which Lackawanna Steel Sheet Piling can be driven is indicated in the above picture and is further indicated by the fact that the closure in the steel sheet piling wall was made without the slightest difficulty.

Other pictures of this work after the Lackawanna Steel Sheet Piling had served its purpose will be shown in our advertisement next week.

In the meantime you would be well repaid by reading our book—"Lackawanna Steel Sheet Piling" which tells about other important cofferdam work and will be sent free to managing and contracting engineers.

LACKAWANNA STEEL COMPANY

General Sales Office and Works: Lackawanna, N. Y.

NEW YORK
BOSTON
BUFFALO
PHILADELPHIA
CLEVELAND
CINCINNATI
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DETROIT
ST. LOUIS
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Licensees for the manufacture of Lackawanna Steel Sheet Piling:

For Great Britain and British Colonies in the Eastern Hemisphere, Cargo-Fleet-Iron Co., Ltd., Middlesborough, England. For France, Italy, Spain, French Colonies and Protectorates, Italian Colonies and Spanish Colonies in the Eastern Hemisphere: Cie Des Forges & Aciéries de la Marine et d'Homécourt, Paris, France.

Engineering News

VOLUME 75 JUNE 22, 1916 NUMBER 25

Emergency Pumping with 412-Ft. Single-Stage Centrifugals

The City of Lynchburg, Va., has recently completed the installation of two emergency pumping plants that will keep the city supplied with chlorinated river water in case its mountain-reservoir supply is interrupted. In one of these plants there are two 3,000,000-gal. single-stage centrifugal pumps working against 412 ft. total head and showing on official test 79.5% efficiency.

Lynchburg is spread over the sides and tops of hills alongside the James River. On the highest hill in town is a reservoir having a capacity of 4,000,000 gal. and with its flow line 320 ft. above the river. In the center of this, the College Hill reservoir, is located a standpipe (Fig. 1) with its top 40 ft. above the reservoir level. About 100 ft. below the College Hill reservoir—that is, 220 ft. above the James River—is the Clay St. reservoir of 3,500,000 gal. capacity. About 22 mi. from Lynchburg is the city's mountain reservoir of 500,000,000 gal. capacity and with its flow line 143 ft. above the top of the standpipe of the College Hill reservoir. A 30-in. pipe line connects the mountain reservoir and the College Hill reservoir; this comprises about 16,000 ft. of steel pipe, 6,000 ft. of cast-iron pipe and the remainder of wood-stave pipe. The maximum pressure on iron or steel is 200 lb. per sq.in.; and on the wood, 100 lb. This line crosses under the James River once. It was completed in 1907 at a total cost, including the reservoir and dam, of $700,000. The line has a capacity of 8,000,000 gal. per day, while the present draft is 4,000,000 to 5,000,000. In some seasons the rate drops to as low as 3,500,000 per day. The city has a population of about 30,000.

The pipe line from the mountain reservoir goes to the center of the College Hill reservoir and up the standpipe to the top. The flow passes downward between this supply and the standpipe shell, flowing into the reservoir over the stonework, as shown in Fig. 1. This arrangement permits supplying a portion of the city known as Rivermont—the best residential area and about one-third of the city.

The College Hill reservoir supplies directly about one-third the town. Part of its water flows down through a pipe to the center of the Clay St. reservoir, 100 ft. below, this last in turn feeding the lowest third of the city at a permissible pressure. It is seen that with this arrangement, if the pipe line breaks, the Rivermont district is at once out of water—although the other two-thirds of the city would be supplied for something more than one day.

FIG. 1. COLLEGE HILL RESERVOIR AND RIVERMONT STANDPIPE, LYNCHBURG, VA.

To insure a continuous supply for the highest district, the station and equipment illustrated in Fig. 2 were installed. This station draws from the College Hill reservoir and returns to the top of the standpipe through the terminal of the 30-in. main, the mountain-supply valve being closed during such operations. The College Hill pumping station has in it one 8-in. single-stage double-suction bronze-fitted centrifugal pump, mounted as shown in Fig. 3,

midway between a 50-hp. squirrel-cage 900-r.p.m. three-phase motor and a four-cylinder 5½x6-in. gasoline engine, completely equipped for operation at any moment. The engine, pump and motor are connected by Francke pin couplings, the pins being left out ordinarily between the engine and pump, as the motor is commonly used to drive. In case the electric power is off, the engine-coupling pins are slipped in and the pump and motor rotors are revolved together. This pump is designed to deliver 3,000,000 gal. per day (2,100 gal. per min.) against 60 ft. total head at 865 r.p.m. On official test the pump efficiency was shown to be 79%.

To take the place of the mountain supply in case of an interruption of more than a few hours, resort is had to the old scheme of pumping from the James River. Years ago, before the installation of the gravity system, all the supply was so pumped—by water-power reciprocating units. The same flume that supplied the water for hydraulic power has been converted into a suction bay for a new motor-driven station. The old cast-iron 18-in. pipe line, 5,200 ft. long and running from the river to the center of the College Hill reservoir, has been used for the emergency service.

In the station at the river two 3,000,000-gal. motor-driven units have been placed, taking current from the local electric station. Each motor has its own control panel with circuit breaker, inverse-time-limit relays and indicating instruments. A watt-hour meter records all the input to the plant.

The static head of operation is 354 ft. On account of friction the pumps were designed to deliver 21,000 gal. per min. against 412 ft. total head at 1,765 r.p.m. Since one unit would have to operate mostly alone, the point of maximum efficiency was shifted later to 2,500 gal. per min. The official test efficiency alone was found to be 79.5%, compared with a guarantee of 78%. When operating in parallel, the pumps handled 2,200 gal. per min. at 78% efficiency. These two pumps are each 10-in. horizontal single-stage double-suction horizontally split centrifugals. Each is connected to a 300-hp. 1,800-r.p.m. slip-ring motor. The cost of this equipment was less than that of three-stage volute pumps or two-stage turbine pumps and is thought to be the highest-head single-stage equipment in such service in this country. A liquid chlorine disinfecting equipment has been installed in this station for treating the river water.

These plants were designed by H. L. Shaner, City Engineer, and the construction was under the supervision of R. A. Thomas, Assistant City Engineer. The operation

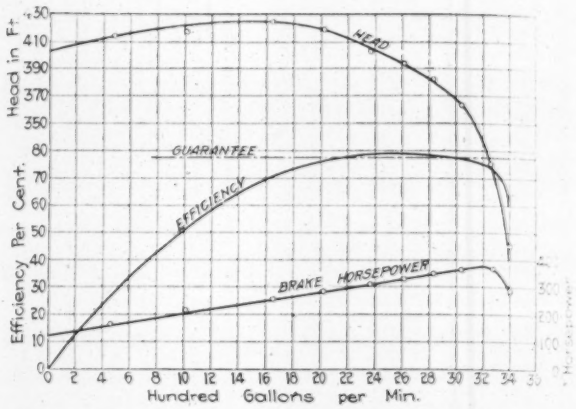

FIG. 5. TEST RESULTS OF LYNCHBURG SINGLE-STAGE 412-FT. PUMP

of the equipment is under W. C. N. Randolph, Jr., Superintendent of the Water Department. Wiley & Wilson, Consulting Engineers, of Lynchburg, were retained by the city as technical advisers. The pumps were built and installed by the American Well Works, of Aurora, Ill. The electrical apparatus and construction were by the General Electric Co., of Schenectady.

Automobiles, Motor Trucks and City Planning*

By Nelson P. Lewis†

In developing a city plan to meet not only existing conditions, but those which may arise in the future, it must be borne in mind that there is no one thing that will more powerfully affect such a plan than the change of conditions brought about by improved methods of getting from one part of the city to another.

In the case of vehicles devoted to pleasure traffic the higher speed and the enormous increase in their number involve questions of safety in the public streets and of traffic control. When most of our city streets were badly paved and only a few of the chief thoroughfares had street surfaces over which one could ride in comfort, there was serious congestion on these few streets. As our city streets become better paved and more attractive and as

*From a paper read before the City Planning Conference, Cleveland, Ohio, June, 1916. The paper in full appeared in the June issue of "The City Plan," the official organ of the National Conference on City Planning (19 Congress St., Boston, Mass.).

†Chief Engineer of the Board of Estimate and Apportionment, New York City.

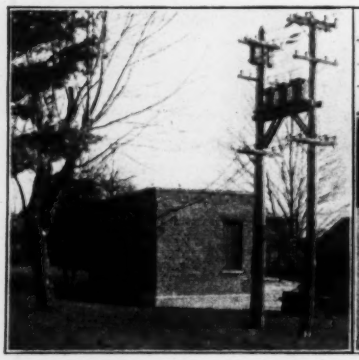

FIG. 2. COLLEGE HILL STATION

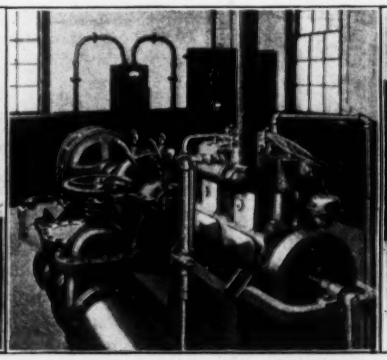

FIG. 3. COLLEGE HILL PUMP

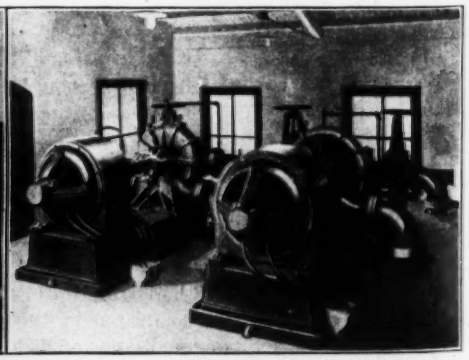

FIG. 4. SINGLE-STAGE 412-FT. PUMPS

the passage from one street to another is made easy by good connections and the avoidance of too abrupt turns and offsets, the motor car will be more and more disposed to follow the lines of least resistance and streets which are more attractive, even if it involves a greater distance.

So far as the obstruction of traffic is concerned, the small commercial vehicles present the same problems as do those designed for pleasure traffic, but in the case of the truck of large capacity an entirely different set of problems is presented, these being: Damage to pavements by reason of excessive wheel loads; obstruction to traffic by reason of low speeds; occupation of an undue proportion of the street, owing to their constantly increasing dimensions. Of the 221 manufacturers in this country producing commercial vehicles at the beginning of the present year 133 confine themselves to those of less than 3 tons capacity and none go above 7½ tons. These will not be considered in the following analysis. Of the 88 makers now offering trucks of more than 3 tons capacity, 58 have made no change in maximum capacity in their models for 1916; 12 have increased, 6 have decreased, and of 12 newcomers only two offer 5-ton and one offers a 6-ton truck. The popularity of the 3½-ton and the 5-ton trucks is quite noticeable.

Six of the largest makers of motor trucks, one organization dealing with the technical problems of their design and one devoting itself to the promotion of their use, have expressed their opinions as to the probable economic limits of weight of car, load capacity and load on rear axle. The maximum weight of car is estimated at from 10,000 to 12,000 lb., the load capacity at from 10,000 to 16,000 lb., and the load carried on the rear axle at from 16,750 to 24,000 lb. There is a very rational basis for the prediction that the maximum limit of weight will be about 6 tons.

Perhaps the most important consideration from the city-planning point of view is the size of the vehicle, more particularly its width and its flexibility. The manufacturers and others whose opinions have already been given with respect to loads and speed have indicated that the wheel base varies from 12 ft. 6 in. to 17 ft. 4 in., the over-all length from 22 ft. to 28 ft., the gage between centers of tires from 5 ft. 10 in. to 6 ft. 3 in., and the over-all width from 7 ft. 4 in. to 8 ft., the opinion also being expressed that these will be the probable limiting dimensions, although the width of special loads, such as plate glass carried flat, may exceed the over-all width in a few instances.

If a roadway in which there are no railroad tracks is designed to accommodate four lines of traffic, allowing 8 ft. for each line, which would permit 2 ft. of free space between the great majority of vehicles, and if trucks measuring 8 ft. over all are permitted on public streets, this width of 8 ft. for a line of moving vehicles will be insufficient. The roadway capacity will be actually reduced to three lines of traffic, and that means that the street capacity for accommodating vehicles will be reduced almost one-half by reason of the fact that the third or middle strip must accommodate vehicles moving in both directions, and the interference will be so great that the capacity of this middle strip will be very small.

The greatest traffic congestion commonly occurs on streets where there are costly buildings and where widening is out of the question. The obvious method of relief in such cases, where part of the sidewalk cannot be converted into roadway, is to establish detours or by-passes around such congested streets or districts, making such routes attractive by means of better pavements and easier grades, and even widening existing and cutting through new streets where the damage to property would be least.

The conclusions of the writer will be briefly presented, as follows:

1. The effect of the motor vehicle upon the city plan of the future, and that means upon city planning, will be beneficial in that it will aid in bringing about some of the most important results that city planners are striving to attain, such as:

(a) The discouragement of further centralization of population; (b) land values will be more diffused; (c) a better class of street and road improvements will be insisted upon.

2. While the amount of traffic on important thoroughfares will be greatly increased, the greater speed and flexibility of the motor vehicle will permit a much greater volume of traffic to be accommodated with safety in the same street, provided:

(a) That the speed and movement of all vehicles are controlled by intelligent police regulations; (b) that the width of commercial vehicles is so regulated that the number of lines of traffic which a street can accommodate will not be reduced and the capacity of the roadway thereby seriously curtailed; (c) that the wheel loads are so restricted that the sustaining power of street pavement and foundation is not exceeded. The most rational way to do this would be to prohibit wheel loads in excess of 700 lb. per inch-width of tire, and these only on rubber tires, the maximum loads on steel tires to be less, or say 600 lb. per inch of width.

3. The greatest congestion, delay and danger will be found where the traffic is most mixed. The traffic problem will, therefore, be simplified if heavy manufacturing, business and residences are confined so far as possible to certain well-defined districts.

4. Horse-drawn traffic requires relatively light grades. Motor cars and trucks can overcome much steeper grades and considerable expense can, therefore, be saved in regulating streets as they can conform more closely to the topography. The greater speed of the motor vehicle will also justify longer detours to avoid excessive grades, and little time will be lost thereby.

5. While street corners and junctions should be improved wherever possible, manufacturers of motor vehicles should understand that they must adapt their vehicles to street conditions wherever possible. The mobility of such vehicles, the short turning radius for the heaviest motor trucks, and the ingenuity which has been displayed in the design of trailers which will follow the tractor without the cutting of corners give promise that such adaptation to existing conditions is possible.

6. With decreasing cost of light motor cars and with the likelihood of cheaper fuel the number of such cars will doubtless continue to increase. The problem of their accommodation in public streets will solve itself with the improvement of the character of road surfaces, although a serious problem will be presented in providing for the accommodation of standing cars. This will undoubtedly require the widening of roadways where possible at the expense of the sidewalks and the provision at frequent intervals of parking spaces where cars may be left and cared for at a moderate charge.

Grit Chamber and Pump Station, Albany Sewage-Works--I

By John H. Gregory*

SYNOPSIS—Sewage-works to treat an average daily flow of 30,000,000 gal. and a maximum flow of 45,000,000 gal. consist of a gate chamber, bar screens, grit chamber, pumping station and Imhoff tank. Grit chamber is given cross-section and provided with proportional weir at outlet end, so as to give an approximately constant velocity. Clamshell bucket and dump-cars remove grit. The unique pumping station will be described in a later issue.

In a previous article[1] a brief description was given of the sewage-disposal works now under construction by the City of Albany, N. Y., to prevent a continuation of the offensive conditions in the Albany Basin, a small land-locked harbor that the city has improved at considerable expense, and also to prevent the excessive pollution of the Hudson River in general along the Albany water-front. It is the purpose of the present article to describe the Westerlo grit chamber and sewage-pumping station which are being built in connection with, and immediately adjacent to, the disposal works and which contain a number of features that may be of especial interest to engineers having to do with the design of such structures. A very much smaller station, known as the Patroons pumping station, is also being built for pumping the sewage from North Albany, a district which is not tributary to the intercepting sewer by gravity.

It may be well to state here that the disposal works provide, for the present, only for the clarification of the sewage by Imhoff tanks, but are so arranged that additional treatment works can be added at any time in the future without rearrangement or reconstruction of the present installation. The disposal works now under construction have a capacity to treat an average daily sewage flow of 30,000,000 gal., with an assumed maximum rate of flow of 45,000,000 gal. per 24 hr. With the works enlarged to the ultimate extent for which they are laid out, which is 50% in excess of the present capacity, they would then be able to treat an average daily sewage flow of 45,000,000 gal. and with an assumed maximum rate of flow of 67,500,000 gal. per 24 hr.

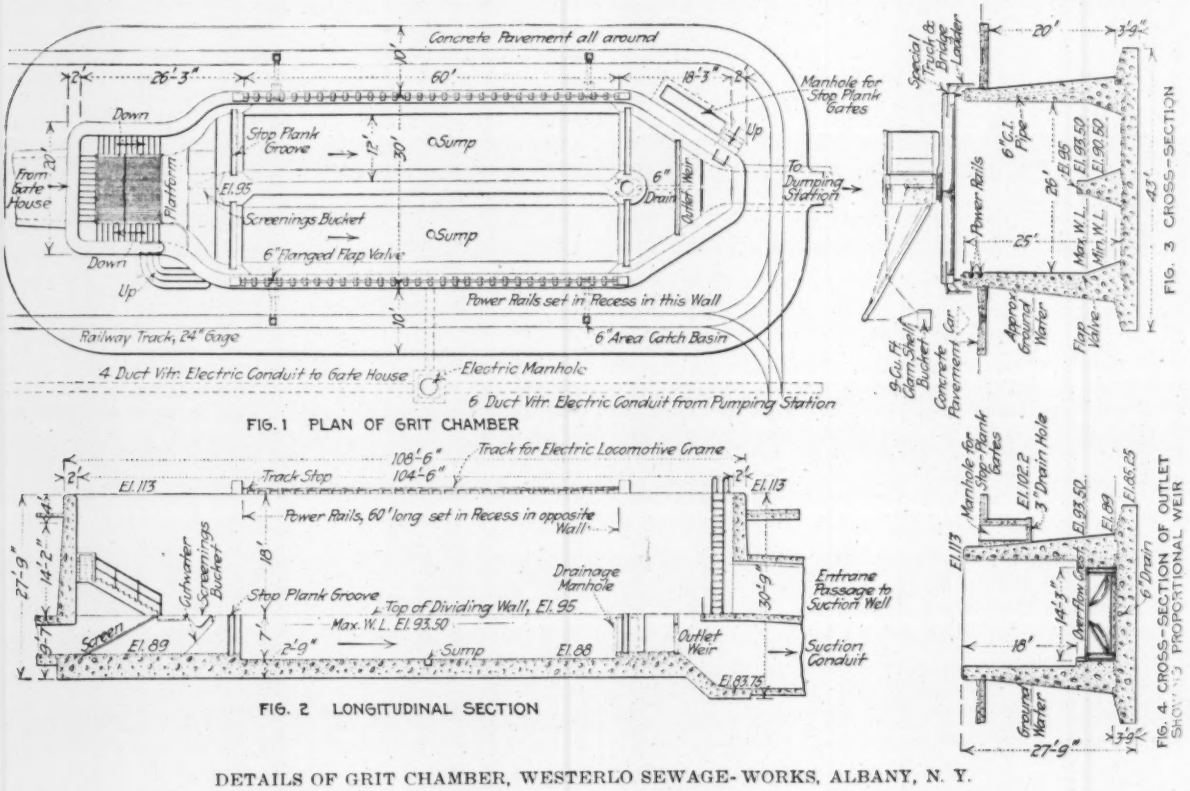

FIG. 1 PLAN OF GRIT CHAMBER

FIG. 3 CROSS-SECTION

FIG. 2 LONGITUDINAL SECTION

FIG. 4 CROSS-SECTION OF OUTLET SHOWING PROPORTIONAL WEIR

DETAILS OF GRIT CHAMBER, WESTERLO SEWAGE-WORKS, ALBANY, N. Y.

Albany is sewered on the combined system, and it is planned to pump and treat only the dry-weather sewage flow. It is possible, however, during the early years of operation to handle some storm water when the maximum rate of dry-weather flow is less than that for which the works are designed, and it will always be possible to handle some storm water runoff, provided it does not occur at the same time of day as the maximum rate of dry-weather flow.

At the disposal works the sewage first passes through a gate chamber, thence to and through a grit chamber, first being screened at the inlet end of the grit chamber.

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[1] "Engineering News," Oct. 7, 1915, p. 692.

and then through a suction conduit to the sewage-pumping station, from which it is pumped to the Imhoff tanks.

At the site of the works the ground is below maximum flood level in the river, and a levee has been built for safety. A levee is also being built to protect the gate chamber, grit chamber and pumping station, and in addition the walls of both the gate chamber and the pumping station are carried up above flood level. The walls of the grit chamber, however, are below maximum flood level, as the level of the sewage in the grit chamber during high water can be controlled at the gate chamber.

The gate chamber is a small structure built at the terminus of the intercepting sewer; and it is possible here to throttle the sewage flow or shut it off entirely by means of an electrically operated sluice gate controlled either from the gatehouse above or from the pumping station, as may be desired. With the flow throttled, or shut off entirely, the storm-water overflows on the lateral combined sewers, from which the intercepting sewer receives the dry-weather flow, will automatically come into action and afford an outlet to the river.

Screens and Disposal of Screenings

The plan and longitudinal section of the grit chamber are shown in Figs. 1 and 2, and cross-sections in Figs. 3 and 4. A coarse screen is placed at the inlet end, through which the sewage passes before entering the grit chamber proper. This screen, which is set at an angle of 27° with the horizontal, consists of ½x3-in. steel bars spaced 2 in. apart in the clear and is made up in sections that are removable so that the spacing of the bars can be changed should operating conditions render such a change advisable.

As the screen is planned to remove only the coarsest of the floating and suspended matters and only such as might injure the pumping machinery and as it will not require constant attention, it will be cleaned by hand, the operator standing on a platform against which the upper end of the screen rests. Access to the platform is from above by a stairway starting at the top of the grit-chamber walls.

The screenings, after being raked up onto the platform, are pushed into a so-called screenings bucket which is set in an opening in, and whose top is flush with the top of, the platform. The bucket has a capacity of 18 cu.ft. and consists of the body of a dump-car of the same size and type as those provided for transporting grit away from the grit chamber and sludge from the sludge-drying beds. The bottom of the bucket and also the sides for a height of 12 in. up from the bottom are perforated so as to allow the screenings to drain. The bucket, which is properly fitted therefor, will be raised by a locomotive crane and set on the running gear of, or its contents tipped into, a dump-car. The screenings will then be transported to the point of final disposal.

The grit chamber proper, in which it is intended to remove only the coarser and heavier mineral matters, consists of two compartments, each 12 ft. in width at the maximum high-water line and 60 ft. in length. The compartments are separated by a low dividing wall and have the same cross-section; under ordinary operating conditions both will be continuously in service.

The cross-section of the compartments, assuming the bottom of the cross-section to be at the same elevation as the invert of the inlet sewer, was so designed that, with the inlet sewer running about one-half full, corresponding to the average daily rate of dry-weather sewage flow when the works have reached their ultimate capacity, the mean velocity through the chamber, with both compartments in service, will be about 1 ft. per sec. As the compartments of the grit chamber have a length of 60 ft., the period of retention in the chamber proper will be about 1 min.

Cross-Sections to Maintain Uniform Velocity

While it is possible to give a grit chamber such a cross-section that a mean velocity through it of 1 ft. per sec. can be maintained with variations in the rate of sewage flow above and below the average rate of flow, it will very often be found that the cross-section will be of such a shape that a structure having such a cross-section would hardly be built. From a practical standpoint, however, it is possible to give a grit chamber such a cross-section that the variation in velocity from a mean velocity of 1 ft. per sec. will not be so great as to be a serious matter unless the ratio of the present average minimum rate of flow to the future maximum rate of flow is extreme.

In the grit chamber at Albany, with an ultimate average minimum rate of flow of two-thirds and an ultimate average maximum rate of flow of one and one-half the ultimate average rate of flow, the velocity will vary from a minimum of about 0.90 to a maximum of about 1.14 ft. per sec. During the earlier years, when the rates of flow are somewhat less than the ultimate rates, the velocities through the chamber will be correspondingly less. For example, with rates of flow two-thirds the ultimate rates the velocities through the grit chamber will vary from a minimum of about 0.76 to a maximum of about 1 ft. per sec.; with rates of flow as low as one-half the ultimate rates the velocities will vary from a minimum of about 0.67 to a maximum of about 0.90 ft. per sec.

Proportional Weir and Automatic Pump Control

In designing the cross-section of, and in computing the velocities through, the grit chamber at various rates of flow it has been assumed that the rise and fall of the water surface in the chamber will be synchronous with the rise and fall of the water surface in the inlet sewer. To secure this hydraulic condition, a proportional weir is inserted at the outlet end of the grit chamber, the crest of the weir being set a certain distance above the invert of the inlet sewer and the sides of the weir being given such a shape that, with the water surface in the grit chamber at any given elevation above the crest of the weir, which elevation will practically be the same as that of the water surface in the inlet sewer, the weir will then discharge at substantially the same rate at which sewage flows from the inlet sewer into the grit chamber.

One other condition is required—that is, the level of the sewage in the suction well shall not rise above the crest of the weir. This second condition is secured under ordinary operating conditions by automatic control of the pumping machinery so that the rate of pumping corresponds to the rate of inflow of sewage into the well.

Proportional weirs are not new and have been used for several purposes, and rectangular weirs have been used

at the outlet end of grit chambers. As far as the writer is aware, however, the Albany grit chamber is the first one actually under construction in which a proportional weir is to be used for controlling the flow through the chamber so that changing hydraulic conditions below the grit chamber will not affect the velocity of flow through the chamber and thereby possibly defeat the purpose for which the chamber was built, although the writer designed a grit chamber for the City of Trenton, N. J., some two years ago, nearly as large as, and quite similar to, the Albany one and in which a proportional weir was included.

The grit pits are shallow, the bottoms of the pits being only 1 ft. below the invert of the inlet sewer. The shallower the grit pits the less they will affect the velocity of flow through the grit chamber, and as a general proposition shallow grit pits with frequent cleaning are to be preferred to deeper pits with less frequent cleaning.

Clamshell Bucket and Dump-Cars to Remove Grit

The grit deposited in the pits will be removed by a clamshell bucket of 9 cu.ft. capacity, controlled from above by an electrically operated locomotive crane having a special bridge and end trucks. The crane tracks or runways are carried on the outer walls of the grit chamber and have sufficient length so that all parts of both pits can be easily reached by the bucket. The electric current for operating the crane will be carried by two power rails set in recesses in, and near the top of, one of the outer walls of the grit chamber. By placing the power rails in recesses they are protected from any damage that might occur to them due to the raising and lowering of the bucket.

The bottoms of the grit pits are flat; to protect them from serious abrasion by the bucket, steel T-rails are embedded in the concrete, the rails being set with the flange uppermost and flush with the surface of the concrete.

Under ordinary conditions it is intended to keep both compartments of the grit chamber in service while grit is being removed; but should it be found desirable to shut off the flow temporarily through one compartment while grit is being removed from it, this can be done by inserting a wooden stop-plank gate in grooves either at the upstream or the downstream end of the compartment, the stop-plank gate being handled by the locomotive crane.

Should it be desired to unwater a compartment, this can be done by inserting stop-plank gates at both ends of the compartment and then draining the sewage out through a manhole located in the downstream end of the dividing wall. From this manhole a pipe leads to the suction conduit which in turn connects with the suction well in which the level of the sewage will be lowered by increasing the rate of pumping, to a point at which the draining of the closed-off grit-chamber compartment will take place.

The grit will be discharged from the clamshell bucket into dump-cars running on tracks located adjacent to the walls of the grit chamber and will then be transported either to the sludge-drying beds for resurfacing them after sludge has been removed or to the point of final disposal. The cars will be hauled and moved about by a small storage-battery locomotive that will serve also for moving the sludge dump-cars.

Calming Rough Water with Compressed Air

Breaking up waves by means of a "reef" of air is a method of beach and pier protection that has been experimented with for the past 12 years and has now proved its practicability, according to the inventor, Philip Brasher, of the Brasher Breakwater Co., 141 Broadway, New York City. Under the Brasher system compressed air is expelled from a submerged perforated pipe so placed as to protect the beach or pier. The air pressure *per se* is not a factor in the successful operation of the system; a sufficient volume of air is the prime requisite. Patent

FIG. 1. LOOKING LANDWARD FROM END OF EL SEGUNDO (CALIF.) PIER THE DAY BEFORE IT WAS WASHED OUT

for this method was granted in 1907, and since then a number of plants have been installed and the following questions investigated: How much air is required per foot of perforated pipe? How can this air be evenly distributed? Will the perforated pipe fill up with sand? How much will the system cost?

Seven plants have been placed under various conditions of mud, sand and rocky bottoms and depths of water ranging from 17 to 50 ft. The latest plant to be established was one in front of the Standard Oil Co. pier at El Segundo, Calif. This pier, originally 4,000 ft. long, was badly damaged in the winter of 1914-15, when nearly 2,000 ft. of it was washed away. In an endeavor to protect the remainder of the pier the Brasher system was tried. This consisted of three sections of pipe, as shown in the sketch (Fig. 4), the first section, 120 ft. long, being laid in front of the pier and at a distance from

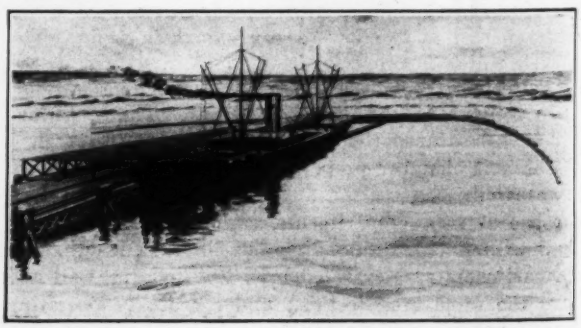

FIG. 2. ESTIMATED CONDITIONS AT END OF STANDARD OIL PIER (EL SEGUNDO) IF PROTECTED
With overlapping pipes on sand bottom

the pierhead of 145 ft. The other two sections are 100 ft. each and lie at right angles to the pier, one on each side, starting from the pierhead. The small cost of operation of this plant is shown by the fact that in 23 hr. operation during the height of a heavy winter storm the cost was only about $60. At the point where the pipes were laid the bottom was sandy and the water 30 ft. deep.

The particular installation described is of course inadequate to protect much more than the pierhead. A more elaborate design has been drawn up for this location. Fig. 2 is an idealized view of conditions that should obtain when it is in service. An extensive system of pipe is provided and is so controlled from the pier that the air can be blown into any particular section, depending upon the direction of the storm.

The several plants installed up to date cost from $10 to $20 per ft. protected. Navigation is not impeded, as the pipes lie on the bottom. It has been determined that with ¼-in. perforations the pipes do not fill with sand. The sand accumulates above them when not in use; but when the air is turned on, the sand is blown away. In protecting bathing beaches the invisibility of the system has another advantage. The distributing pipes usually are 4 in. in diameter. The ¼-in. holes are spaced 6 in. apart. From 3 to 10 cu.ft. of free air is required per lineal foot of beach protected.

At Brighton Beach, L. I., one of these systems was put in about six years ago partly for experimental purposes and partly to protect the bathing beach. The air compressor was operated by an induction motor using central-station current. The surf at this point is not very heavy, and after two years the plant was taken out. Pipes were laid at a depth of 17 ft., to protect 600 ft. of beach.

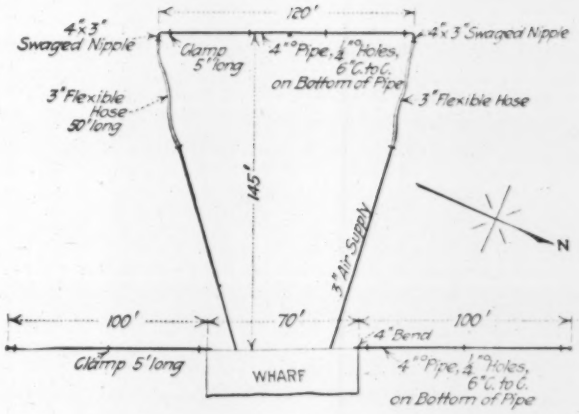

FIG. 4. EXISTING AIR-BREAKWATER EQUIPMENT AT EL SEGUNDO

On the Pacific Coast hundreds of miles separate the few safe harbors from one another. There are a number of piers at various locations, but the landing of vessels is a precarious operation and one that is not infrequently interrupted. If the Brasher system furnishes at reasonable cost safe harbors in time of storm, its commercial success is certain. Mr. Brasher sums up the advantages of his system as follows: "Thus protected, dredges can be kept working in exposed places during rough weather. The erection of seawalls, piers, lighthouses, etc., may be continued steadily. Partly completed structures may be protected until finished. Lightships can ride out the roughest gale in an artificial lagoon of calm sea. Stranded vessels can be protected from the pounding of the waves until floated."

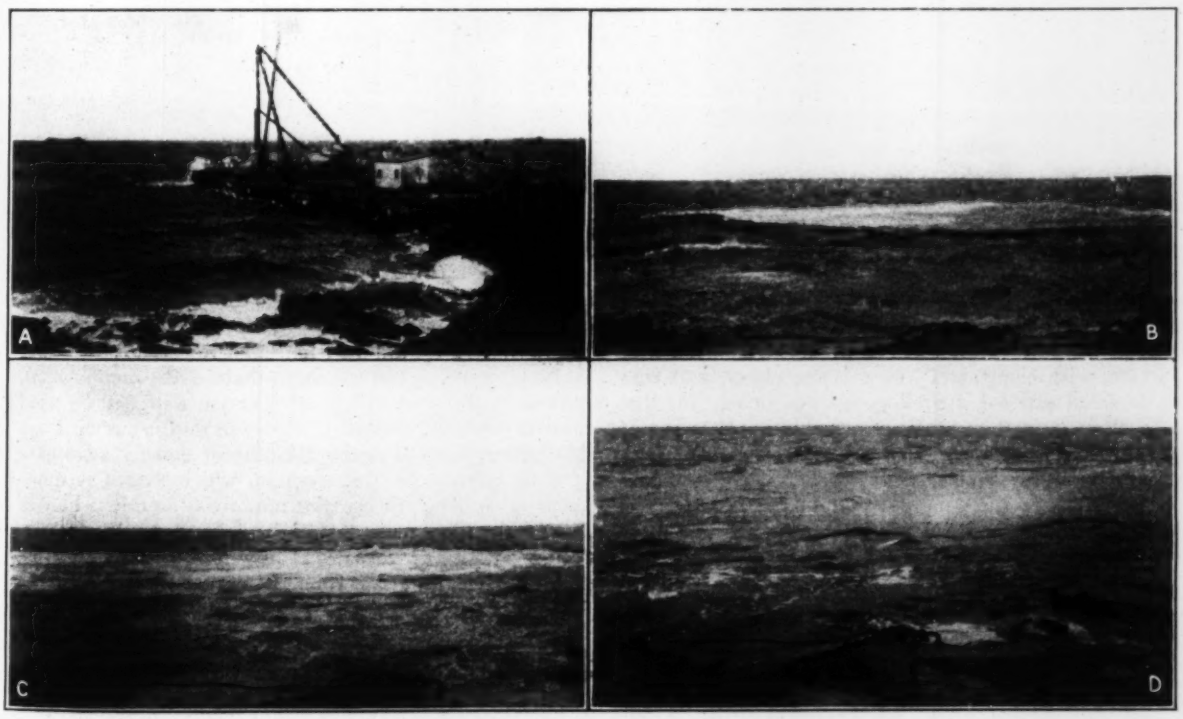

FIG. 3. SHOWING THE EFFECT OF THE BRASHER SYSTEM OF THE PIER AT GLOUCESTER (MASS.) QUARRY
A—Air off. B—Air just turned on. C—After few minutes of operation. D—Air just turned off

Snowsheds and Tunnels on the Great Northern Ry.

SYNOPSIS—About $1,500,000 to be expended on snowsheds this season, including both concrete and timber construction. Mostly double-track work. Also tunnels and concrete galleries for changes to improve location.

On the line of the Great Northern Ry. crossing the Cascade Mountains, in Washington, extensive improvements have been made to reduce the serious troubles caused by snow. These troubles include the blocking of the line by heavy snowfalls, and both blocking and damage by heavy snowslides. With increased traffic, very large expenditures have been warranted to protect the line and prevent interruption to train service.

The main part of the work consists of snowshed construction, with changes of line at some places, and tunnels to avoid exposed sidehill points and enable the line to be thrown farther back into the hill. In view of the heavy traffic all work on permanent location or relocation is built for double track, single-track work being done only where there is prospect of relocation. The snowsheds are of special interest in that for a considerable portion of the work the usual all-timber construction is replaced by a design having a concrete back wall and timber posts supporting the roof timbers. This is described below.

Where the railway loops down the western slope of the mountain for ten miles between Tye (at the end of the Cascade tunnel) and Scenic, about 58% of the distance is now protected against snow troubles. With the work to be done this season, about 76% will be thus protected. Nearly $1,500,000 will be spent on snowshed construction, while other improvements will bring the total cost of the season's operations to about $2,000,000. The work includes the following items:

On the east slope, 8,000 lin.ft. of new timber snowsheds between Leavenworth and the Cascade tunnel, $500,000. On the west slope, 3,700 ft. of combination concrete and timber snowsheds (3,000 ft. of which replaces old timber sheds), $500,000; 6,100 ft. of new timber sheds (100 ft. replacing old sheds), $450,000; changes of line at bridges Nos. 398 and 402, including 450 ft. of double-track concrete arch gallery and 2,650 ft. of tunnel, $550,000. Total cost, $2,000,000.

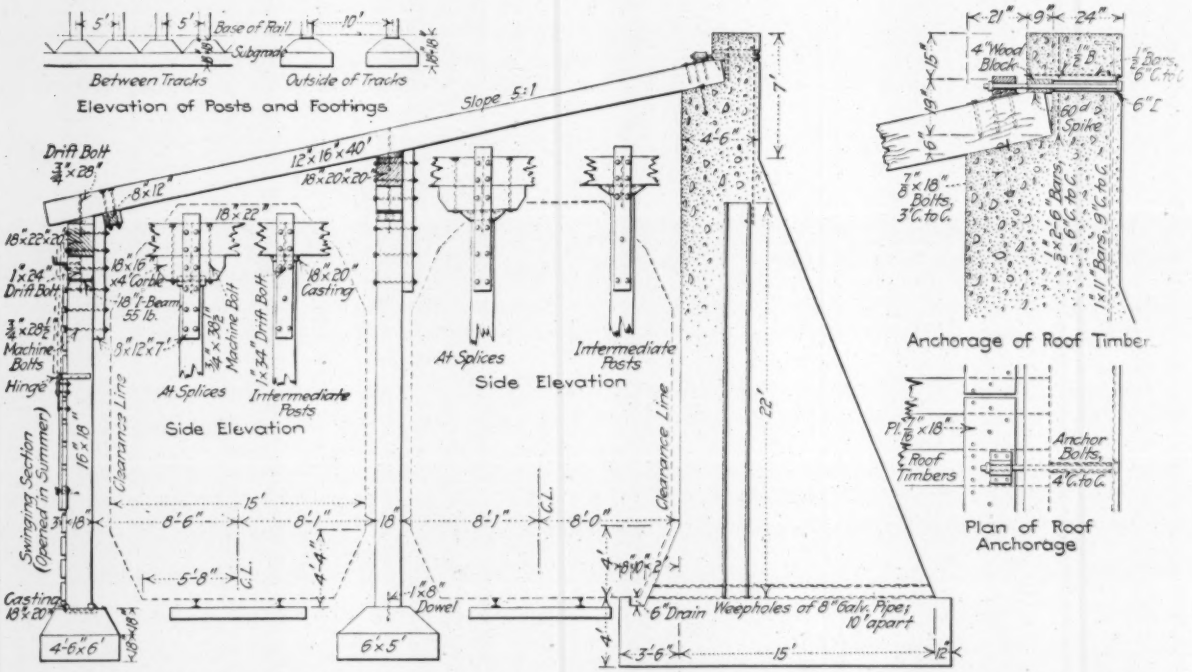

FIG. 1. SNOWSHEDS OF COMBINATION CONCRETE AND TIMBER CONSTRUCTION, GREAT NORTHERN RY.

The designs for the snowsheds are shown in Figs. 1 and 2. They are practically identical with those for the previous work on this division, described in *Engineering News* of June 4, 1914, except that in the combination snowsheds the gravity type of concrete wall will be used most extensively, instead of the reinforced-concrete type. The reason for this is the difficulty of getting aggregate of good quality for the concrete, which makes it questionable economy to use the reinforced section where a small amount of poor material might result in unsatisfactory results or perhaps failure to withstand a slide.

A point of difference from the earlier design is in the method of fastening the roof timbers to the concrete wall. The roof consists of 16x16-in. transverse timbers laid close together. In the earlier construction the ends of these timbers rested on and were drift-bolted to a 16x16-in. beveled timber set in a recess in the top of the wall. No trouble has developed with this form of fastening, but it has been thought best to strengthen this point

In the new design, shown in detail in Fig. 1, the roof timbers rest directly on the wall and are notched to fit over the projecting leg of a continuous 4x5-in. T-bar embedded in the concrete. The ends of the timbers are housed beneath a projecting ledge on the wall, with 4-in. wood blocks wedged between the timber and the ledge.

The roof timbers are securely anchored to the wall by horizontal 1½-in. bolts which pass through 2-in. sleeves and have their heads held in a 6-in. channel on the back of the wall. Upon the roof timbers is spiked a line of steel plates $\frac{7}{16}$x18 in., in lengths of 11 ft. 11 in., secured by drift bolts. Upon these plates are riveted socket castings for the anchor bolts, the nuts being screwed up against the castings. These anchor bolts are spaced 4 ft. c. to c.

The concrete wall will be built in sections not more than 48 ft. long, with no bond between adjacent sections. The shed as shown is designed for a load of 1,500 lb. per sq.ft. For a load of 1,000 lb., the roof timbers are 12x12-in., the outer and inner posts are 12x16-in. and 16x20-in. respectively, and all posts spaced 10 ft. c. to c.

The construction of the timber snowsheds is shown clearly in Fig. 2 and needs little description. The bents are of 12x12-in. timbers, with plank braces; they are spaced 4 ft. c. to c. where heavy slides are to be expected and 8 ft. c. to c. for lighter slides. Where the ground is flat on the outer side of the shed, the crib support for the outer posts is omitted and the roof is extended over an additional panel, as shown by the dotted lines.

In rough and steep ground, cribbing is used to support the intermediate posts on the uphill side. In flat earth slopes, however, these posts rest on caps and continuous sills, like the main posts of the bent.

Tunnels and Galleries

The improvement of the line through the Cascade Mountains this season will include changes of line at two points. Each of these will eliminate a bridge and some curvature. At one of these changes there will be two tunnels, 2,050 and 900 ft. long, with 250 ft. of concrete arch gallery. The other will have a 600-ft. tunnel and 200 ft. of arch gallery.

These galleries form a specially interesting feature of the work, being practically double-track tunnels built in opencut in sidehill ground and forming protected approaches to the rock tunnels. The approximate maximum section of gallery is shown in Fig. 3. The interior section is similar to that of the tunnel, noted below.

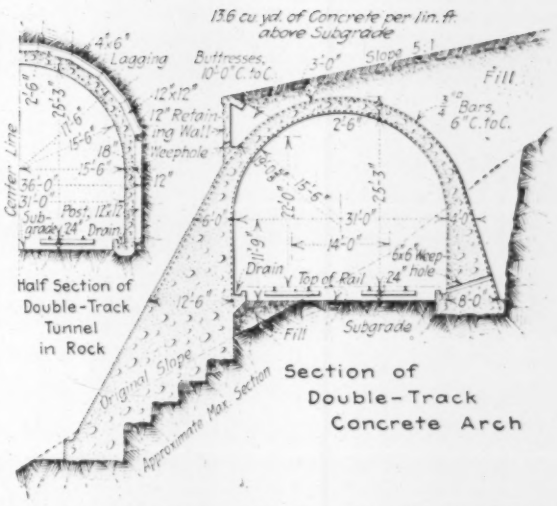

FIG. 3. CONCRETE GALLERIES AND DOUBLE-TRACK ROCK TUNNELS, GREAT NORTHERN RY.

The roof is reinforced with steel bars, and the side walls are carried down to broad footings.

To protect the gallery from slides, it is covered with backfilling, finished to a slope of 1 on 5 extending from the natural surface of the hillside. The fill is 3 ft. deep over the arch, and its toe is held by a 12-in. reinforced-concrete retaining wall, with buttresses 10 ft. apart. Weep holes in this wall provide for drainage of the fill.

The double-track tunnel in rock, Fig. 3, is of wide section, the clear width between walls being 31 ft., with tracks spaced 14 ft. c. to c. The roof is semicircular, giving a clearance of 25 ft. 3 in. above the rail level at the center line and 22 ft. above the outer rail of each track. The tunnel is timbered, with posts and roof segments 12x12 in., and 4x6-in. lagging over the roof. The bents are spaced 4 ft. c. to c. The concrete lining is 18 in. thick in the walls and 30 in. in the arch, these being the clear dimensions inside of the timbering. The walls are shaped to form concrete gutters or drains along the footings.

The top of the rail is 2 ft. above the subgrade. This tunnel section requires for each foot of length a neat excavation of 36½ cu.yd., and 7.13 cu.yd. of concrete for the lining. The single-track tunnel section in rock is 17 ft. wide and 24 ft. high, with a semicircular arch. Its area is 377 sq.ft., requiring 14 cu.yd. of excavation per lineal foot.

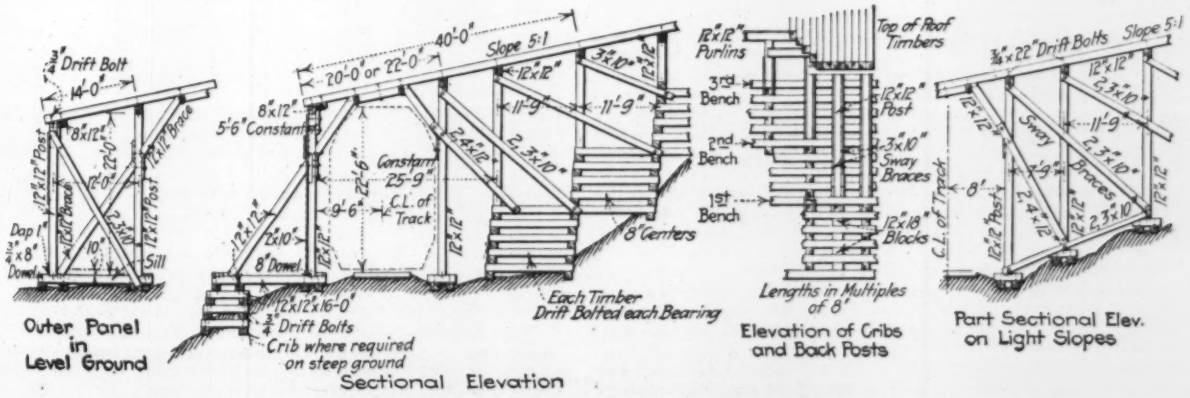

FIG. 2. TIMBER SNOWSHEDS ON THE GREAT NORTHERN RY.

Contracts have been awarded to Grant Smith & Co., of Spokane, Wash., W. J. Hoy & Co., of St. Paul, Minn., and Henry McPhee & Co., of Seattle, Wash. The work is under the direction of A. H. Hogeland, Chief Engineer, Great Northern Ry., St. Paul, Minn., and O. S. Bowen, Principal Assistant Engineer, Seattle, Wash.

Building a New Type of Dam in the Colorado River

In taking water from the Colorado River for the irrigation of the Imperial Valley, a problem of much difficulty has been the maintenance of the supply to the intake during the low-water season. A paper is to be read before the American Society of Civil Engineers on Sept. 26 (published in the "Proceedings" for May), on the "Control of the Colorado River and the Protection of the Imperial Valley." The author of the paper, J. C. Allison, of Calexico, Calif., is Chief Engineer of the California Development Co. Mr. Allison describes how in the low-water period of 1910 it became necessary to build a temporary rock weir across the Colorado River to raise the level high enough to maintain the flow in the intake. This weir cost $32,350 and raised the water a maximum of 3.4 ft. It was maintained during the season of low water with great difficulty and expense. In March, 1911, the trestle of the dam was removed, and the War Department forbade the dumping of further material in the river channel.

In 1915 a new type of hydraulic fill diversion dam was built across the channel of the Colorado. Mr. Allison describes the experience which led to the building of this dam and the methods adopted in its construction as follows:

Sole dependence for a sufficient water supply for Imperial Valley after 1910 was placed on the hydraulic dredge "Imperial," operating below the headgates, and on the dredge "El Centro," operating above the headgate in the intake canal and in the Colorado River channel, controlling sand bar obstructions, etc.

The actual computed yardage of solid material moved by the dredge "Imperial" from the canal below the headgate in one season's operations is equal to just one-tenth of 1% of the solid matter discharged through Hanlon headgate in the same interval, but it is also a fact that it was just this one-tenth of 1% of solid matter which had heretofore blocked the canal delivery below the headgate before the dredge was put in operation.

The major part of the one-tenth of 1% of solid matter removed by the "Imperial" was shingle, ranging from 1-in. rock to ¼-in. gravel, and sand ranging from gravel down to materials which are retained on a No. 10 mesh screen. It was the discovery of this fact that led to the successful operation of the Hanlon Heading, from the time of the entire removal of the rock weir in 1911 up to the present. This grade of material has been removed systematically every year since the dredge has been in operation, thus permitting the bed of the canal below the headgate to be maintained at an elevation which gave a sufficiently low water surface in the canal at all times. All other sands and silts not removed by the "Imperial" are carried down the canal in suspension.

The fact that there was deposited below the headgate, at times when the velocities in the intake exceeded 6 ft. per sec., material of a kind which could not be carried down the canal by the velocities below the headgate, which are never greater than 4 ft. per sec., led to the discovery of a means by which a hydraulic-fill dam could be placed across the Colorado River at a point directly below the intake, to serve as a means of diverting sufficient water into the Imperial Canal, should the necessity ever again arise. This time did arrive during the summer of 1915, because of the combination of an exceptionally low Colorado River during August and September, and an exceptionally great demand for water in Imperial Valley, due to the large increase in irrigated acreage over the previous years.

A study of the cross-section of the channel of the Colorado at Hanlon Heading, and the gaging station of the United States Reclamation Service at Yuma, shows that the Colorado—like other rivers forming deltas—scours and refills its channel bed with the increase and decrease of quantities of water, and that a direct relation exists between the character of the materials forming the bed and the velocities of the water. For example: The river bed is scoured to an elevation of 85 at Yuma, Ariz., by a discharge of 140,800 sec.-ft., whereas it is refilled to an elevation of about 140 by a discharge of 3,400 sec.-ft. The only reason that the bed does not scour deeper than an elevation of 85, with a discharge of 140,800 sec.-ft., is that at that depth the materials constituting the bottom are so heavy that the velocities, registered as 6.8 ft. per sec. for this discharge, will not move them. It follows that, in refilling the bed, the materials are graded as to weight, and deposited in direct relation to the velocities.

Though this is by no means a new discovery, the experience with the dredge "Imperial" below the headgate served to bring out more strikingly the real relations between the weights of materials and the velocities, and showed a way to make a practical use of this knowledge.

The scour line of the bed of the Colorado at Hanlon Heading (the intake of the canal) is at an elevation of about 84. The ladder of the 10-in. suction dredge "El Centro," operating in the river and above the concrete heading, was designed so as to make it possible to pump from an elevation of 80 when the surface of the river was 110. The materials in this area below the scour line had withstood the scouring effects of velocities as high as 7 and 8 ft. per sec. Those materials, when brought to the surface and deposited in the water where the velocity had decreased to 2 and 3 ft. per sec., due to falling discharge, were certain to stand in the position placed by the discharge of the dredge, making it possible to construct a hydraulic-fill dam under the water of a running stream varying in depth from 2 to 15 ft.

HYDRAULIC-FILL DIVERSION DAM

On Aug. 12, the "El Centro" commenced the construction of such a dam below the intake, and in 14 days had raised the fill to an elevation of 12 in. above the water surface three-fourths the distance across the river. This fill reached from the Arizona bank of the river to within 250 ft. of the California shore, or a total length of fill of 650 ft. Due to the contraction of the channel during this period, a head of somewhat more than 1 ft. was developed, which resulted in a corresponding increase in velocity through the remaining opening. The velocities resulting from this head became as great as those developed during flood discharge of the river, and consequently material pumped from below the scour line could no longer be deposited in the dam with any degree of economy, without adopting some method of decreasing the velocities. In closing the last 250 ft., therefore, a great quantity of brush and sacks filled with gravel was used.

The closure of the final 75 ft. of the channel represented the most difficult operation in the construction of the dam, and the means devised for making this closure again demonstrated the advantage of close observation of the action of a river when left to itself, and the application of the results of this study in a practical way.

From Aug. 12 to Sept. 12 was the period of principal construction. The time subsequent to Sept. 12 was spent principally in making the final closure and in maintaining the structure. On Aug. 12 the river was discharging 8,800 sec.-ft. Of this discharge, 2,529 sec.-ft. were flowing into the Imperial Canal, all the gates in the heading being fully opened. The requirement for irrigation in Imperial Valley was 5,000 sec.-ft. By Sept. 12, the river discharge had dropped to 4,000 sec.-ft. During this period of 30 days there was used in the construction of the dam:

40,000 cu.yd. of sand and gravel fill, at 2.7c. per yd.	$1,080.00
21,300 burlap and canvas sacks, at 3 to 6½c. each...	1,140.00
450 cords of willow brush and poles, at 73c. per cord	328.50
800 lb. of wire	32.00
Cables and clamps	100.00
Labor, filling and placing sacks, carrying and placing brush, poles, etc.	2,000.00
	$4,680.50
Plus 10% for superintendence and tools, etc.	468.05
Total	$5,148.55

Since Sept. 12 there has been an additional expense of $2,000 for raising and strengthening the dam by dredging, and for labor in closing and opening the dam, and general maintenance of the structure, making the total final cost $7,148.55.

The following methods were used in constructing the major part of the dam: Pumping was commenced on the Arizona side, the dredge pontoon being some distance above the site of the dam, and the discharge being carried astern through a 10-in. pipe floated on pontoons to the fill. Owing

to the admixture of lighter grades of material encountered in burying the suction pipe to the scour line depth, and to the subsequent caving in on the suction of the surface materials when the depth was once reached, the base of the dam, in a great many places, became as wide as 150 ft. The heaviest materials pumped—in some instances stones and cemented adobe chunks 6 in. in diameter—remained exactly where placed, but the lighter sands and gravel were carried by the current some distance down stream before they lodged in permanent position. When a point near the water surface was reached with the fill, the conservation of the material was made possible by constructing brush fences to help retain the material at the slope required. By this process the structure was carried across the stream to the point of final closure. Three re-runs across were made later with the dredge, bringing the crown to an elevation of 114, which is about 5 ft. above the water surface of the river when 5,000 sec.-ft. are passing into the canal.

On Sept. 10, 2,300 sec.-ft. were passing through the opening in the dam, and 3,300 sec.-ft. had been diverted into the Imperial Canal. The head on the dam was 2 ft., and the resulting velocity through the remaining opening was 8 ft. per sec. The bottom of the opening had been paved with about 10,000 sacks, filled with gravel pumped by the dredge, and stoutly tied, decreasing the depth to about 5 ft., and thereby preventing scour. Great quantities of sacks were used in protecting the Arizona end of the opening, the California shore, as before stated, being protected by its rock facing. Additional sacks were used in forming the overpour riffles as fast as the head developed. A great number of the sacks were of no avail, either because of their lodgment in the wrong place, or because of breaking and washing out; and, throughout the whole process, constant replacements were required because of the boring effects at the toe of the sack riffles, causing the embedding of the sacks.

In paving the bottom, the point above the opening at which the sacks should be dropped in order that they might lodge on the bottom in the proper place, was determined by constantly experimenting with sacks thrown overboard attached to wires, thus making it possible to locate the sack when it had finally settled by following the line of the wire. Only those filled with the coarsest shingle and gravel and of greatest weight would remain in position and withstand the velocity for any length of time.

In the final closure, when the bottom had been protected carefully, cables were stretched across, securely anchored to deadmen on the California side and in the body of the dam on the Arizona side. The first cables used were of ¾-in. plow steel, but proved to be too light when maximum strains were put on them. After one failure in making the closure, due to breaking the cable, a double strand of 1¼-in. cable was used for the lower run.

Willow poles were cut from the Arizona and California shores near-by, where the supply is abundant. The poles were 30 ft. long, the diameter of the large end being 10 in., and the small end tapering to 5 or 6 in. By the skillful use of barges and lines working above the openings, these poles were maneuvered with the current in such a manner as to cause their large ends to lodge against the cable stretched across the opening above the water surface, while the small ends rested on the bottom at an angle of 30°, much as a drifting snag will lodge in a swiftly running stream when the heavy end is dragging the bottom and the upper end encounters a surface obstruction of trees or other large drift. These poles were placed against the cable, in this manner, with enough space (sometimes 4 or 6 in. between them) to give sufficient strength to the structure and yet not decrease the area in the opening so greatly as to produce much additional head. When all the poles were in place, large bundles of willow brush were made up, weighted heavily with sacks, and rolled into the water from the barges, anchored some distance above the opening, in such manner as to cause them to strike the bottom of the channel and roll against the lower ends of the poles. As additional bundles were thrown in, the pressure against the poles increased, forcing them to bend, until in some instances, before final relief to the strain was obtained, the upper parts of the poles were standing vertically, and the lower sections were bowed to the extreme. Green poles were always chosen because of their flexibility.

The placing of the bundles of brush was carried on in sections only, and only in sufficient quantity to decrease the velocity through the section to a point where material deposited by the dredge could be retained in place. In this manner the strain against the poles in any section of the opening was of short duration, as the dredge would give relief in a few hours by extending the dam above. Of course, a great many sections failed during the work, because of poles breaking, but means were at hand for speedy replacement when such accidents occurred. Because the impounded area above the dam was so great as to require several hours to increase its elevation when flow through the opening was reduced, the extra heads created by stoppage with the brush were not felt on the poles to any great extent before the dredge had given relief.

After numerous local failures, due to small freshet rises in the river, and the breaking of cables and poles, the opening was entirely closed on Sept. 20, the head then being 6.4 ft. and the discharge of the river, measured at Hanlon Heading, 2,958 sec.-ft. Between Sept. 20 and 27 the river discharge fluctuated between 3,000 and 4,000 sec.-ft., all of it being required for irrigation in Imperial Valley. On Sept. 27, because of advance notice from Needles of a rise in the river, the dam was cut at a place provided, and all water, with the exception of 4,000 sec.-ft., was passed through into the channel of the Colorado River below.

The waters thus let through the dam were forced into the California bank below by local obstructions, so that on Oct. 2 the opening in the dam was again closed, and all the water was diverted into the Imperial Canal. The discharge of the Colorado River on Oct. 2, as measured at Hanlon Heading, was 4,406 sec.-ft. The second closing head was 8.2 ft. (The closing head of the Hind rock-filled dam, on Nov. 4, 1906, was 15.8 ft., with a river discharge of 9,275 sec.-ft.)

The 36 hour. following the second closure were spent in clearing obstructions in the channel immediately below the dam, and in providing a new waterway to train the flow away from the California shore. On the evening of Oct. 3, the dam was again cut at the place provided, because of a rise in the river in excess of the water requirements in Imperial Valley. During the period from Oct. 3 to the present writing, the opening in the dam, 100 ft. in width, has been left, and through it the discharge has been as great as 8,000 sec.-ft. In constructing the dam, provision was made for accommodating the freshet discharges of the river, which commonly occur during October and November. These sections will be sacrificed only as required, because of the fact that during December and January the discharge of the river commonly reaches the minimum, and this being a year of exceptionally low water, it is quite likely that the irrigation requirements of Imperial Valley will again make it necessary to close the dam fully. Entire removal probably will be advisable in March or April, 1916, and by that time it will have fulfilled its purpose as a means of diverting sufficient water to meet the irrigation demands of the Valley. In any event, the annual flow period of May and June, 1916, will remove the structure entirely. If the conditions which develop before this time should require it, the whole structure could be speedily removed by mining, as it is composed entirely of brush, sacks and gravel, with the exception of a few willow poles driven with the aid of a jet from the dredge. The structure contains absolutely nothing of a permanent nature.

The experience in building this dam has developed naturally a great many improvements which would be adopted in a second construction of similar nature; so that such a dam could be built in a much shorter period and with much less expense. For instance, by constructing an aërial tramway, anchored to towers on each bank of the river, dredge lines can be carried across the stream during its flood, thus enabling the dredge to venture into the river during much higher water, resulting in earlier completion of the work. The ladder of the dredge "El Centro" is to be lengthened 15 ft., enabling it to pump material at a greater depth below the scour line. These two improvements alone will permit the commencement of the dam while the river is discharging 56,000 sec.-ft., and will permit the complete diversion of a river carrying 15,000 sec.-ft. if necessary. More economical use of sacks and the labor attending can be achieved by a more general use of cable and pole manipulation in closing the final opening. Fewer accidents in the final closure will be assured by anticipating the material requirements in time to accumulate sufficient quantities of poles and brush. By lengthening the pontoon and pipe line of the dredge, thus providing an increased radius of operation, a large supply of material suitable for construction can be obtained.

Utilization of Material from Old Freight Cars is being practiced systematically by the Baltimore & Ohio R.R., and the mechanical department estimates a salvage of $20 per car in this way. The lumber is sawed and planed to remove defective portions and to give suitable sizes. It is then distributed for use in repair work and for building small structures, freight platforms, etc. Bolts, nuts, wheels, rods and other metal parts are sorted, trimmed and stored. The results have been so satisfactory that a reclamation plant has been established at Zanesville, Ohio, to which are sent all cars that are to be scrapped or destroyed. Reclamation work of a lighter character is carried on at division repair shops.

New York's Military Map of the Year 1778

By Frank B. Tucker*

As an example of the work of the military topographer of the closing quarter of the Eighteenth Century, the map herewith reproduced is an achievement to be proud of. The map itself is understood to be in the British Museum. A chance visitor to the Topographical Bureau, Borough of Queens (to whom due acknowledgement is here made), had a photographic copy of it which he kindly allowed to be photographed in turn. It is undoubtedly the first military map to be made of New York and its environs and possibly the only one; for *Engineering News*, no longer ago than Apr. 20 last, called attention editorially to the lack of such a map, citing only Charleston as a city with a military map, credit for which belongs to the Confederacy.

BRITISH MAP FOR DEFENSE OF NEW YORK CITY, 1778

If ordered by Clinton as commander-in-chief, it was started sometime subsequent to May, 1778, the date on which he succeeded Lord Howe. Presumably, he sought to forestall being trapped in New York as Gage had been in Boston and as the Americans would have been in New York, had it not been for Washington's consummate skill in withdrawing therefrom.

While for military purposes the map has long ago outgrown its usefulness, as an example of the surveyor's art antedating present-day instruments of precision and as a source of historic information it well deserves careful study. The accuracy of the map is remarkable. Shore and coast lines, islands and hills, roads and trails are truly defined and readily identified on comparison with recent maps. The locality names that stud the map are in common use today and serve to distinguish different sections of the city. The highways that then obtained are for the most part the arterial thoroughfares of Greater New York. In some cases they have been widened and straightened to meet the needs of highly populated communities; in other cases they are still country roads with the same kinks and turns that Clinton's surveyors plotted.

Applying the scale of the map, it is evident that some system of control was used, distant points measuring remarkably close, nearer points only slightly less so. It may be that a number of fixtures were astronomically established and then connected up by traverses run with a compass and some kind of a perambulator.

To the student of American history the map is a key to many valuable data. Not alone does it show the topography and road system as it existed about New York in 1781, but it shows also the buildings that lined the roads, in a number of instances giving the occupant's name, as in the case of the Abthorpe mansion, where Washington was when the battle of Harlem Heights started. That the strategist of this period recognized the need of a thorough knowledge of the topography of the country as a basis for military preparedness, this map bears silent witness.

To the student of logistics the map is a true plan of the battles of Long Island and of Harlem Heights, which General Carrington in his "Battles of the American Revolution" sought to compile from records and descriptions of the battles. It was at Gravesend Bay, Aug. 22, 1776, that the British landed. On the twenty-seventh they moved northward along the several roads leading toward Brooklyn, to attack the Americans who guarded the passes of the roads through the ridge of hills, then heavily wooded, where now are Prospect Park and Greenwood Cemetery. The Americans succeeded fairly well in holding their own until Clinton and Cornwallis reached their rear by way of the Jamaica and Bedford road, foolishly left unguarded; then all was confusion. Washington, two days later, under cover of storm and darkness, crossed the East River from the fort on Brooklyn Heights (shown on the map) to New York. The British followed later from near Newtown Creek. The battle of Harlem Heights (about where Columbia College is now) was fought on Sept. 16. Washington then withdrew all except the garrison of Fort Washington, at the north end of New York island, to White Plains, licked the British at Chatterton Hill, then crossed to New Jersey. The British returned to New York, captured Fort Washington and continued in undisputed possession of the city until the end of the war.

*Topographical Bureau, Borough of Queens, New York City.

Wheel-Load and Impact Charts for Railway Bridges

By D. B. Steinman*

The accompanying three diagrams, constructed on the same plan as the writer's Chart of Equivalent Uniform Loads (*Engineering News*, Apr. 22, 1916), have been devised as additional time-savers in railway-bridge computations. The first of these is a diagram giving directly the position of Cooper's loading to produce the maximum value of any stress. The other two give the impact coefficients for any stress by the American Railway Engineering Association formula and the Lindenthal formula respectively.

All of these charts are based on the same principle, namely, that the critical wheel-position for any stress depends only on the lengths, l_1 and l_2, of the two segments of the influence triangle for that stress. Accordingly the three charts consist of curves plotted with l_1 and l_2 as coördinates, the values of l_1 and l_2 for different stresses, applicable to all the charts, being defined in the sketches on the first chart.

Chart of Critical Wheel Loads

This chart gives the critical wheel for any stress, i.e., the number of the wheel, in Cooper's loading, to be placed between l_1 and l_2 to make the stress a maximum. It will be found useful in engineering schools in checking the results obtained by the application of the various analytical and graphical criteria for load positions. It is superior to all such criteria inasmuch as these may be satisfied by a number of different wheels and there is no way, except exhaustive trial, to determine which wheel gives the greatest stress.

The principal use of this chart, however, is to serve as a basis for stress and impact computations and for the construction of other charts which depend upon load positions. Thus, as explained below, this chart was used as a foundation for the construction of the other two.

It should be noted that on or close to the boundary line between any two wheel-areas on this chart, either wheel may be selected, since the difference between the respective resulting stresses is so small as to require very fine computations to disclose it. At such points, therefore, the wheel giving the greater impact stress should be chosen.

This chart may be used for web stresses, as well as for bending moments, chord stresses, floorbeam reactions and pier reactions. In using it for web stresses, however, if wheel 12 or 13 should be indicated, it must be replaced by 3 or 4 respectively to avoid loading the negative portion of the influence diagram. The corresponding correction in Chart 2 is made by disregarding the area bounded by double lines.

The Impact Charts

The object of the impact charts is to save the time of finding the length of loaded train for maximum stress and of substituting this length in the respective impact formulas. Chart 2 is constructed for the American Railway Engineering Association impact formula, which is now the most widely used impact formula in this country. Chart 3 is constructed for G. Lindenthal's impact formula, which is fully explained in an article, "A New Impact Formula," in *Engineering News*, Aug. 1, 1912. The Lindenthal formula appears to be complicated; but by the use of this chart its application becomes very simple and expeditious.

The two impact diagrams were obtained, using the chart of wheel loads as a foundation, by drawing horizontal lines through each wheel-area to represent the successive impact coefficients and then replacing the resulting stepped graphs by continuous curves. This substitution of smooth curves for the broken lines, in addition to simplifying the two charts, serves to provide an automatic correction in those cases, which are missed in the ordinary application of the formula, where the governing wheel for maximum live-load stress should be replaced by another to produce the maximum total stress with impact included.

Either impact diagram may be drawn superimposed upon the writer's chart of equivalent uniform loads,[1] so as to give both the live-load and the impact stress at a single plotting of a point. If it were not for the usual preference to have these two stresses listed separately, a still greater saving of time could easily be effected by combining the A. R. E. A. impact and the equivalent load diagrams into a single set of curves giving directly the equivalent uniform load for total live-load stress with correction for impact already included.

Examples of Use of the Charts

The following examples are selected to show the time-saving value and other advantages of the three charts.[2]

Example 1—Required the critical wheel loads and impact coefficients for all the members of a double-track Pratt truss having six 25-ft. panels.

Referring to the three charts, the following figures are obtained:

Members	l_2	l_1	Critical Wheel (Chart 1)	Impact Coefficients (K) A. R. E. A. (Chart 2)	Impact Coefficients (K) Lindenthal (Chart 3)
L0L2, L0U1	125	25	4 at L1	0.52	1.66
L2L3, U1U2	100	50	14 at L2	0.53	1.70
U2U3	75	75	12 at L3	0.52	1.68
U1L2	100	20	3 at L2	0.57	1.94
U2L3, U2L2	75	15	3 at L3	0.63	2.00
U1L1	25	25	4 at L1	0.77	2.00
L2U3, U3L3	50	10	3 at L2	0.70	2.00

Example 2—For a certain member in a double-track bridge, $l_1 = 40$ and $l_2 = 120$. Required the impact by the A. R. E. A. formula. For $l_1 = 40$ and $l_2 = 120$, Chart 2 gives the impact coefficient $K = 0.51$.

Calculation by means of the impact formula gives a smaller result, $K = 0.496$. This value is obtained by placing between l_1 and l_2, wheel No. 6, which is the critical wheel for maximum live-load stress.

The reason for the above difference between chart and formula is disclosed by Chart 1; this shows that the point ($l_1 = 40$, $l_2 = 120$) lies near the boundary between the areas for wheel 5 and wheel 6, indicating that the two wheels produce nearly the same live-load stress. The impact chart automatically takes this fact into account and gives the impact coefficient which corresponds to wheel 5 ($K = 0.51$) since this will yield the maximum total stress. Similar results are obtained with Chart 3.

Example 3—Required the total bending moment for E60 loading at the center of a 120-ft. plate-girder span, weighing 5,200 lb. per lin.ft.

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*Special Assistant Engineer with Gustav Lindenthal, Consulting Engineer, 68 William St., New York City.

[1] "Engineering News," Apr. 22, 1915.

[2] Large-size copies of any of the above charts, printed in black lines on linen, specially prepared for office use, complete with sketches and formulas, will be sent by the author to any address upon receipt of price, $1.

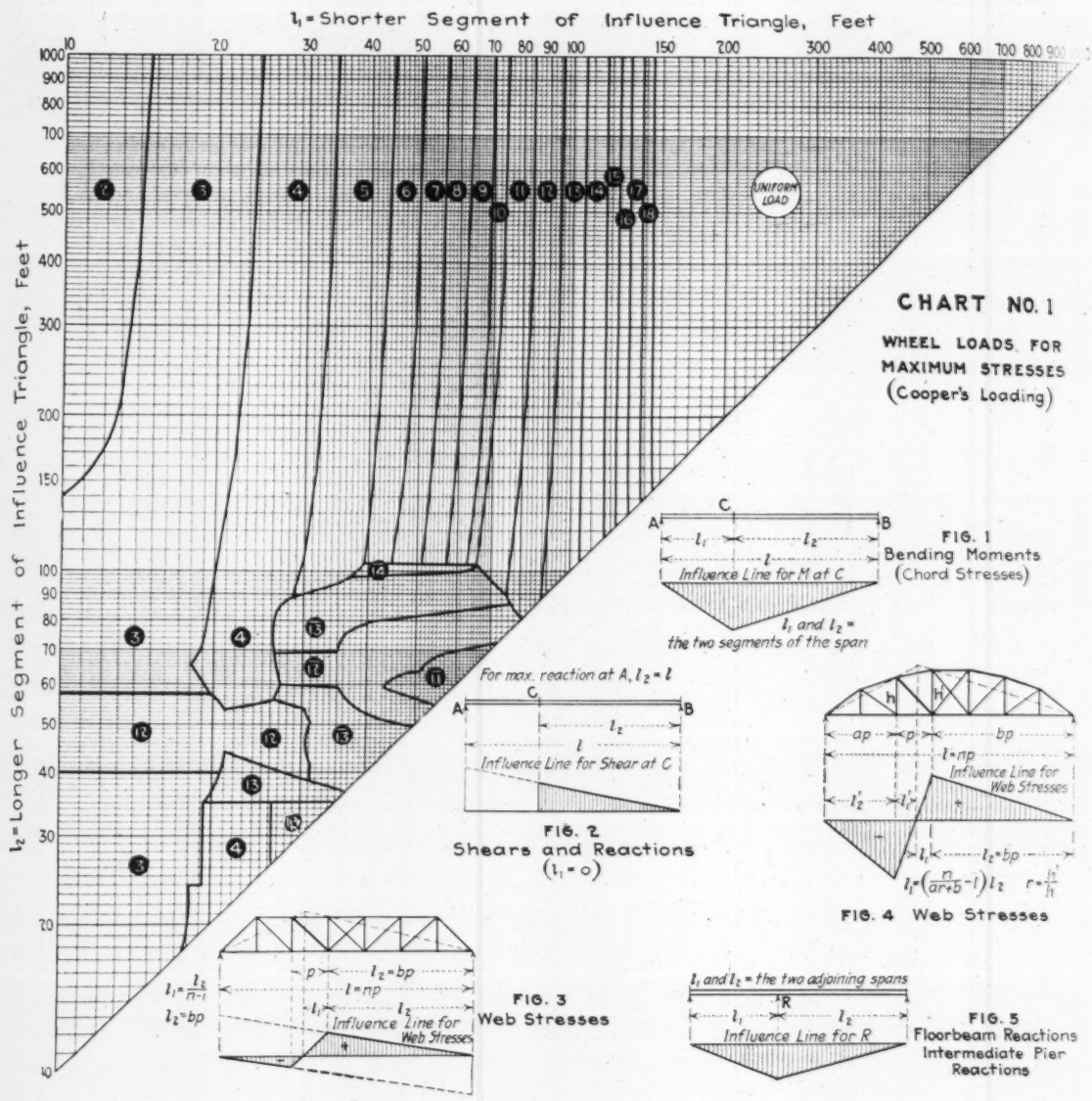

CHART NO. 1

WHEEL LOADS FOR MAXIMUM STRESSES
(Cooper's Loading)

FIG. 1
Bending Moments
(Chord Stresses)

FIG. 2
Shears and Reactions
($l_1 = o$)

FIG. 4 Web Stresses

FIG. 3
Web Stresses

FIG. 5
Floorbeam Reactions
Intermediate Pier Reactions

(These sketches apply to all three charts)

DIRECTIONS FOR USE OF CHART NO. 1

This chart can be used for bending moments, chord stresses, web stresses, floorbeam reactions and intermediate pier reactions.

This chart gives the number of the wheel to be placed between the two segments, l_1 and l_2, to produce the maximum stress.

The shorter segment is ahead followed by the longer one except when the wheel number is overlined.

For $l_1 > 142'$, place head of uniform train load at 142' from head of span.

DIRECTIONS FOR USE OF CHART NO. 2

Use l_1 and l_2 as defined in the above key as coordinates and interpolate between the curves to find "K". Take the value of "K" from the marginal column corresponding to the number of tracks on the structure.

Multiply the live load stress by "K" to obtain the impact stress.

For points on the double lines, use the higher of the two values of "K".

DIRECTIONS FOR USE OF CHART NO. 3

Use l_1 and l_2 as defined in the above key as coordinates and interpolate between the curves to find "K". Take the value of "K" from the marginal column corresponding to the number of tracks on the structure.

$\frac{L^2}{L+D}$ Multiply the value of "K" by to obtain the impact stress.

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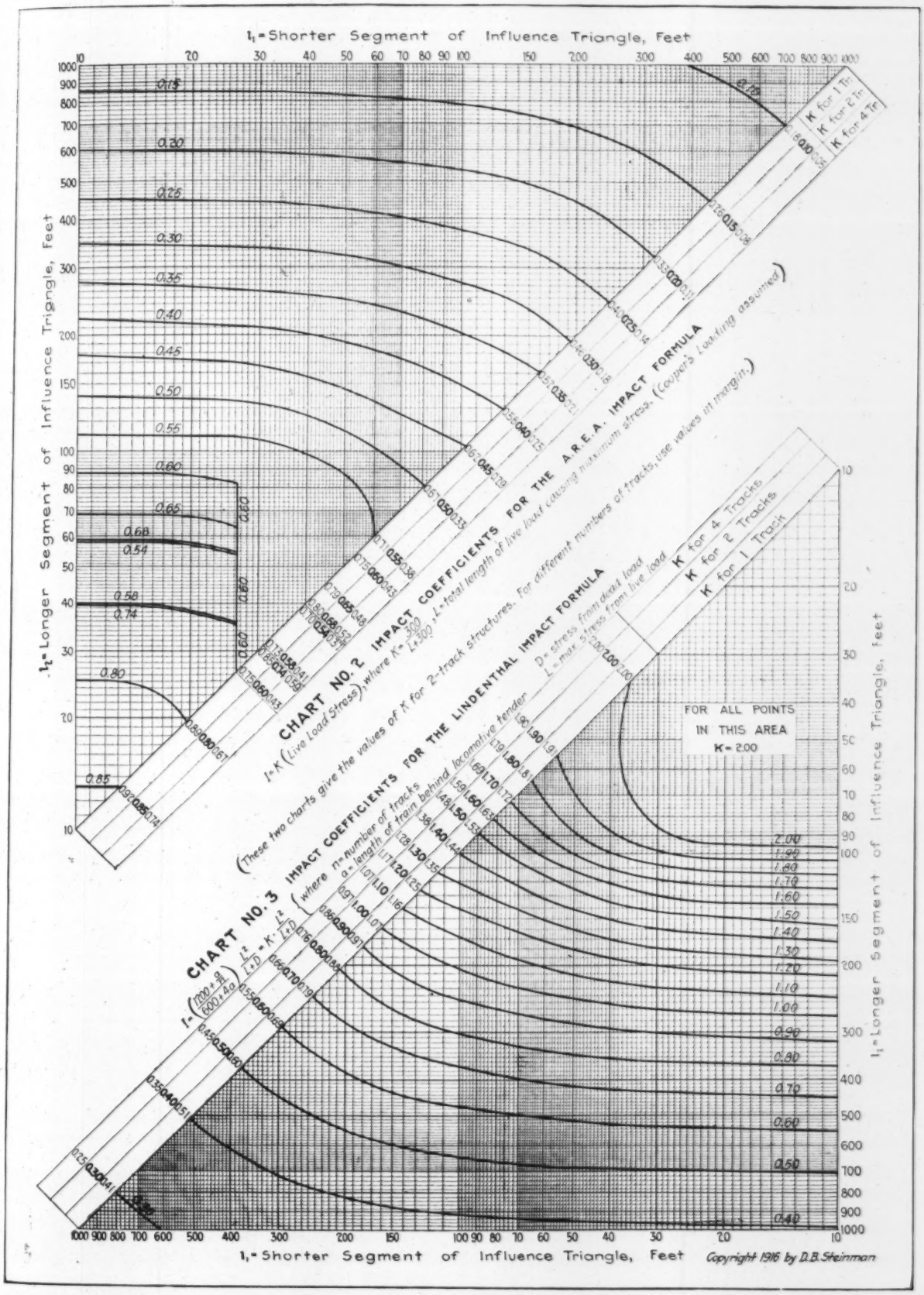
CHART NO. 2. IMPACT COEFFICIENTS FOR THE A.R.E.A. IMPACT FORMULA
(These two charts give the values of K for 2-track structures. For different numbers of tracks, use values in margin.)
I = K (Live Load Stress), where K = 300 / L+300, L = total length of live load causing maximum stress. (Cooper's Loading assumed)
K for 1 Tr.
K for 2 Tr.
K for 4 Tr.
CHART NO. 3 IMPACT COEFFICIENTS FOR THE LINDENTHAL IMPACT FORMULA
(where n = number of tracks, a = length of train behind locomotive tender, D = stress from dead load, L = max. stress from live load)
I = (1200 + 9n/600 + 4a) L²/L+D = K L²/L+D
K for 4 Tracks
K for 2 Tracks
K for 1 Track
FOR ALL POINTS IN THIS AREA K = 2.00
l₁ = Shorter Segment of Influence Triangle, Feet
l₂ = Longer Segment of Influence Triangle, Feet
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In this case $l_1 = l_2 = 60$. By the writer's chart of equivalent uniform loads, $q = 7{,}700$ and the resulting bending moment per girder is

$$L = \tfrac{1}{4}\, q\, l_1 l_2 = 6{,}930{,}000.$$

The dead-load bending moment is

$$D = \frac{5{,}200}{7{,}700} L = 4{,}680{,}000$$

Using the A. R. E. A. impact chart, $K = 0.71$ and

$$I = KL = 4{,}920{,}000.$$

Hence the total bending moment is

$$D + L + I = 16{,}530{,}000.$$

Using the Lindenthal Impact Chart, $K = 1.86$ and

$$I = K \frac{L}{L + D} L = 7{,}700{,}000$$

Hence the total bending moment is

$$D + L + I = 19{,}310{,}000.$$

Although this is greater than the preceding result, the required section will be about the same since the permissible unit stress is 20,000 against 16,000 for the A. R. E. A. specifications.

Example 4—For one of the members of the Hell Gate arch (four-track), $L = 8{,}035{,}000$, $D = 16{,}462{,}000$, $l_1 = 489$ and $l_2 = 489$. To find the impact stress and required cross-section.

For the A. R. E. A. Impact Formula, Chart 2 gives $K = 0.07$. $I = KL = 562{,}000$.

$(D + L + I) \div 16{,}000 = 1{,}570$ sq.in. required.

For the Lindenthal Impact Formula, Chart 3 gives $K = 0.36$. $I = K \dfrac{L}{L + D} L = 950{,}000$.

$(D + L + I) \div 20{,}000 = 1{,}272$ sq.in. required.

For short spans, below 100-ft. for girders and 200-ft. for trusses, the Lindenthal specifications produce somewhat heavier structures than the A. R. E. A. specifications, the difference being principally in the web members. As the spans become longer, the Lindenthal specifications yield an increasing economy.

Concrete Viaduct Versus Fill for Street Elevation

Astoria, Ore., may be called a city on stilts. Situated on tidewater at the mouth of the Columbia River and for many years being without railroad connection, the city naturally grew up about its docks. With growth and expansion the boundaries reached to sidehill ground beyond the tide flats bordering the river, but the business district remained, built upon piling, close to the waterfront.

As Astoria has grown in importance and more substantial buildings have taken the place of the original frame structures, the disadvantages of building on piles elevated above the ground surface has become more apparent. With the development of hydraulic dredging it has been possible to fill in the tide flats with sand pumped from the river channel at a very reasonable cost. By the formation of improvement districts a large portion of the tide flats at Astoria has been filled in, either partly or to street grade.

There has recently been brought up for improvement a district that has been partly filled with dredged material, but in which the surface is still from 8 to 12 ft. below street grade. As an alternative to completing the fill there was suggested a concrete viaduct construction, which received considerable support from various quarters with the result that designs were made and approved by the city council.

Fig. 1 shows typical details of the first unit of viaduct construction, on which bids were called for. This was for the improvement of 11th St. from the railroad right-of-way near the waterfront to Exchange St., a total length of about 950 ft. As may be seen, the construction consists of four-post bents carried on timber piling, and a girder and slab deck. The width, curb to curb, is 34 ft., with 8-ft. cantilever sidewalks to the full street width of 50 ft. Temporary wooden walks were proposed for a part of the work, to be replaced later by concrete slabs. Expansion joints, with lead sliding surfaces, are provided at every third bent, or at 50-ft. centers.

The principal argument in favor of the concrete viaduct construction in the place of a solid fill was that it provided an excellent vault for public utilities, such as telephone, light and power circuits, water, gas and steam-heating pipes. To inclose this vault, it was proposed to build hollow-tile sidewalls between the outer lines of posts, or at the curb line.

The viaduct construction as outlined, while receiving the support of certain local interests in Astoria, was opposed by others, notably several large taxpayers who would be subject to assessment and taxation for the improvement. These taxpayers called upon engineers to make a study of the situation and report upon the relative economy of different forms of construction.

The costs deduced from this study are of particular interest, as they give light on a problem that is often

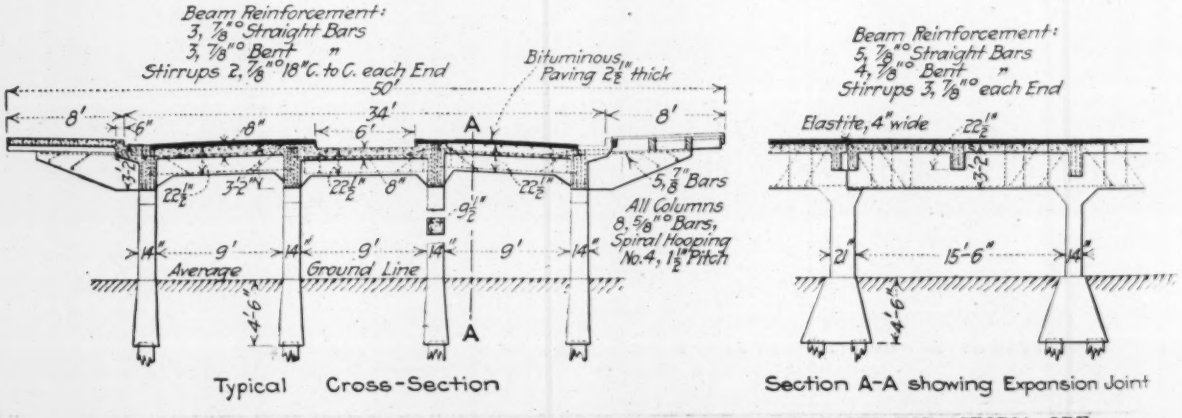
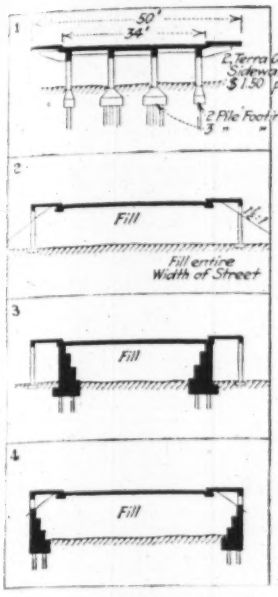


FIG. 1. DETAILS OF REINFORCED-CONCRETE ELEVATED STREET PROPOSED FOR ASTORIA, ORE.



	COST PER LINEAL FOOT		
	Without Sidewalks	With Concrete Sidewalks	With Timber Sidewalks
1	$ 55.60	$ 61.80	$ 57.00
2	$ 17.00	$ 25.30	$ 19.10
		$ 20.00	$ 19.40
3	$ 47.30	$ 55.60	$ 49.60
4	$ 39.80	$ 46.00	$ 41.70

FIG. 2. COMPARATIVE COSTS OF FOUR DIFFERENT TYPES OF ELEVATED STREET

met, in which fills and different types of wall construction are alternatives to open spans. Using the conditions at the proposed 11th St. viaduct in Astoria as standard, designs and estimates of cost were made upon three other forms of construction, comprising a sand-fill with slopes from the street line and two types of retaining-wall construction—one with the wall at the street line and one at the curb line. The alternate designs, together with the summarized costs of each, are given in Fig. 2. For comparison with conditions existing elsewhere the unit costs of materials considered in these estimates may be of value. They are for date of Apr. 13, 1916:

Cement, per barre	$2.00
Sand and gravel, per cubic yard	1.00
Reinforcement, per 100 pounds	4.50
Piling in place, per lineal foot	.20
Excavation, per cubic yard	.50
Paving, per square yard	.75
Lumber in place, per thousand	25.00
Sand-fill, per cubic yard	.20

It will be noticed that the estimated cost of the sand-fill, complete with walks and paving, is $19.40 per lin.ft., against $57 for the viaduct scheme. This comparison was brought out very clearly in the final discussion of the improvement before the city council of Astoria. The figures were confirmed by the testimony of several engineers. In spite of the strong showing made against the viaduct improvement on the ground of cost, the city council approved it and authorized a call for bids.

For surfacing the street upon the viaduct there was specified a patented bituminous paving material. As the use of this material, requiring license from the patentee, would to some extent interfere with free bidding upon the entire improvement, just previous to receiving bids the paving contract was separated from the viaduct.

Subsequent to the opening of bids and before the award of the contract for the viaduct improvement, certain large taxpayers of Astoria brought injunction proceedings, based upon legal technicalities. As the following out of these cases would have delayed all work for a considerable time, the city council of Astoria subsequently agreed to reject all bids and readvertise for a sand-fill.

Concrete Piles 100 Ft. Long

Precast reinforced-concrete piles 100 ft. in length have been used in the construction of wharves at Auckland, New Zealand, and were described in a recent number of *Concrete and Construction Engineering* of London, by F. E. Powell. These piles are the longest concrete piles ever driven.

One of the wharves, about 281x1,200 ft. in plan, required nearly 2,000 piles, and borings showed that in some places it was over 100 ft. from deck level to rock bottom, with some 50 ft. mud and clay overlying the bottom. It was felt that unless the piles were driven to refusal on the rock, there must be some doubt as to the continuity of the girders and beams, all of which were designed as continuous over the supports. Although reinforced-concrete piles 70 ft. long and 18 in. square had been employed in the work, these piles were hollow and light and their handling had not involved any particular difficulty. The difficulty with the longer piles was, of course, in their handling, and a scheme for swinging them into the leads of the piledriver had to be worked out.

Fig. 1 shows a section of the piles and the method of slinging them. The pile as shown there is 20 in. square and 100 ft. long, reinforced with eight longitudinal rods. Near the two ends and at about the third point, cross pipes 4 in. in diameter were put through the pile section to carry 3½-in. pins, to which the slings were attached. The pile is then carried by a wire rope made fast at its ends and running free through the three-sheave block and two snatch blocks secured to the pile, which had to be up-ended and controlled by other ropes until in a vertical position alongside the piledriver leads. In discussing the design of the sling, Mr. Powell says:

> Although the scheme was simple in this form, a large amount of work was necessary before it could be put into execution. Fortunately, the Board had an 80-ton floating steam crane which could be used to assist operations. Then the calculation of the proper points of support had to be made to suit the safe moments of resistance of the piles, having regard to the fact that the rope has equal stress throughout its length, being free to run in all the pulleys, while its angles of inclination to the pile vary with the slope of the pile. Bending moment diagrams were, therefore, made for each point of support over the range of movement and various positions tried until the worst bending moments were always within safe limits. The section of the pile shown was adopted as a trial and found to meet the case. This section was used for all the piles from 60- to 100-ft. lengths, the shorter ones being slung from two points only.

Under the arangement devised it was necessary to have a diver remove the 3½-in. pin at the lower end just prior to diving. When the first pile was slung into place it was found that the three sheave blocks shown in the main part of the diagram jammed badly under the

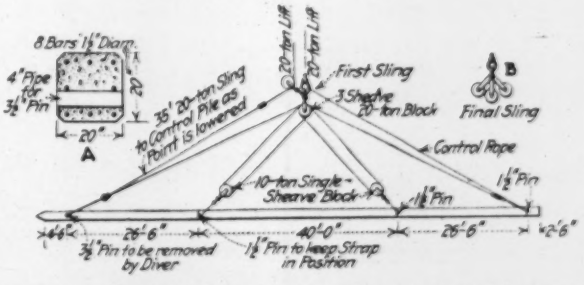


FIG. 1. METHOD OF SLINGING 100-FT. CONCRETE PILE AT AUCKLAND, NEW ZEALAND

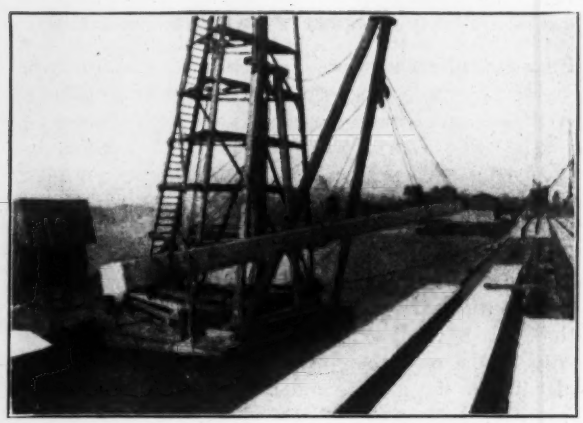


FIG. 2. LIFTING ONE OF THE NEW ZEALAND 100-FT. CONCRETE PILES INTO PLACE

load and a block of the type shown separately in the diagram having the sheaves all in the same plane was made. The piledriver available would not stand up under the work so a new machine had to be built having leads 94 ft. high, with a five-ton hammer.

Deflection of the piles during lifting was very small. The central portion remained practically straight and the maximum deflection at either end about 1¼ in.

A large number of these piles varying from 50 to 100 ft. in length, and 12 to 20 tons in weight, were subsequently made and driven. Only one was broken in the operations. The piles were mostly driven home to the estimated depth but only by long continued hammering. The accompanying view shows one of the piles being swung to the lead in the piledriver.

Large Wheel-Type Excavator

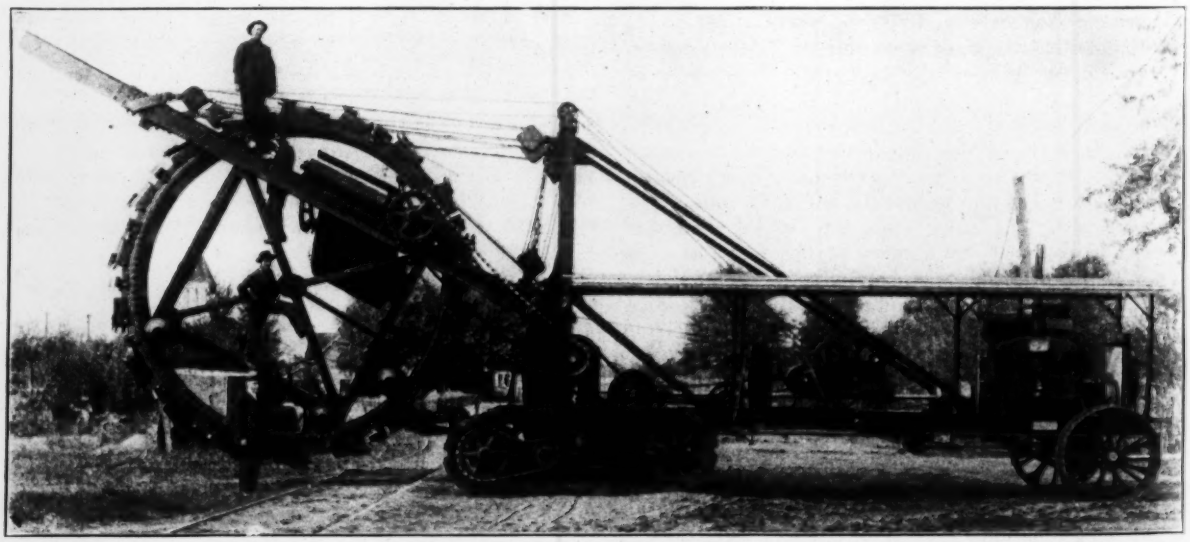
The large trenching machine shown in the accompanying view can dig trenches 42 in. wide to a depth of 12 ft. It is owned by Thornton Bros. Co., contractors, of St. Paul, Minn., and has been used in heavy trenching for sewers and other municipal work. Similar machines of various sizes, and for use in hard and soft ground, are used in ditching and trenching for land drainage, irrigation, pipe lines and municipal work.

The excavating wheel of the machine illustrated is 15 ft. outside diameter and 14½ ft. inside diameter. It has no spokes or hub, but its internal face rides upon steel wheels carried by a rectangular frame attached to the pivoted boom. It has an internal gear on each side, driven by pinions on the boom, with chain drive from the engine on the main frame. The wheel is fitted with "contractors'" toothed buckets for excavating hard material. Alternate buckets have heavy projecting teeth or rooters on the sides to assist the cutting edges of the buckets in trimming the sides of the trench. The buckets deliver their contents upon a broad conveyor belt which discharges the material upon the spoil bank. The outer end of the hinged conveyor frame has a bail with supporting tackle led to a light pipe boom pivoted to the headframe. The conveyor has a friction drive.

The boom consists of two steel channels (between which the wheel works), and has its heel sliding in guides in the vertical head frame. This boom is supported by tackle at each end. Two sets of tackle attached near the outer end of the boom provide for swinging it vertically upon its heel pivot or hinge. Another set is attached to the pivoted end and provides for raising and lowering the heel of the boom in the headframe.

With the boom shifting vertically in this way, there would be variation in the slack of the chains driving the excavator wheel. To provide for this, and thus prevent the chains from fouling the sprockets, a compensating device is required. For this purpose, the lower part of the headframe has curved guides for the heel of the boom, the curve being such that the distance between the driving and driven sprockets is maintained practically uniform. In the smaller machines, the slack is taken care of by idlers on the wheel frame.

The main hoist is at about the middle of the machine. The frame is supported on a pair of wheels at the forward end, and by caterpillars at the rear end. Each caterpillar has a track 3 ft. wide and is 8½ ft. long between the sprocket shafts. One of these shafts has a chain drive, as shown. Upon the frame is a four-cylinder



WHEEL-TYPE EXCAVATOR FOR CUTTING TRENCHES TO A DEPTH OF 12 FT.

100-hp. gasoline engine, furnishing power for the several hoists and for the caterpillars. The road speed is about 1 mi. per hour.

The machine is 52 ft. long and 13 ft. wide over all, with a height of 22 ft. to the top of the headframe, and a working weight of about 43 tons. It was built by the Buckeye Traction Ditcher Co., of Findlay, Ohio.

The machine illustrated has been used by the Thornton Brothers Co., of St. Paul, Minn., for excavating trenches 12½ ft. deep and from 28 to 42 in. wide. Under fair conditions it could dig 700 to 900 ft. of trench per day. The material excavated consisted of 3 ft. of clay, with sand and gravel below. Before this became frozen the sides were allowed to slope, digging down about 8 to 9 ft. deep, which gave a ditch practically 14 to 16 ft. wide on top and narrowing toward the bottom. Afterward the ground froze from 4 to 6 ft. deep, and fires were built ahead of the machine (sometimes requiring a double fire). These thawed the ground approximately 3 ft. deep, and the balance of the frozen material was cut with the excavator. In this way making a cut 7 to 9 ft. deep, the machine dug from 300 to 500 ft. per day.

How to Appraise Water Rights*

By Harry Barker†

SYNOPSIS—It is attempted here to set forth, in place of the confusion now existing among valuation engineers, a logical, sound and reasonable procedure which will be generally acceptable for the valuation of vested rights to use water. Water rights are considered as having fundamentally the nature of industrial real estate and to be appraised on the basis of earning power. To assist in the comparison of water rights of determined and of unknown values, the value of a right is considered as having two factors—a regional and a constructional value. Limitations to the use of steam-power comparisons are noted. Difficulty shown of appraising water rights in rate cases. True value of storage-reservoir sites set forth.

The large amount of water-power valuation being made all over the country, the peculiar results being presented by some well-meaning but uninstructed appraisers and the hesitation of commissions to accept the results make timely a review of defensible procedure in water-rights appraisal. Valuations that can be criticized are those, for example, which set forth the worth of water rights as the "combined intangible and going values of a power development"—locating this as the capitalized possible net annual income. Such a finding has no justification for parading as the value of water rights, although water rights indeed are hidden therein.

Water Rights Must Be Considered

Greatly varying ideas are prevalent as to whether or not a public utility utilizing a water power can include in the rate-basis worth of its plant any allowance for rights to the beneficial use of water.

This has been denied in a few specific cases, notably by the Public Service Commission for the Second District of New York in Fuhrman vs. Cataract Power and Conduit Co. (3 N. Y. Pub. Ser. Comm. 2nd D., 670) on the grounds that the Federal and state permission to use water at Niagara Falls gave the corporation no title to the water and hence no water right measured by the price of steam power. Other commissions, for instance, like those of California (*re* Northern California Power Co., Calif. R.R. Comm. Rep., 1913) and Idaho (*re* Pocatello Water Co. 1 Idaho Pub. Serv. Comm. Orders 78; 1914) appear to have held at one time that water rights were in the nature of fictitious intangibles and so not admissible as part of rate-basis worth.

Later ideas of both these bodies named (see *re* City of Santa Cruz, Calif. R.R. Comm. 2,666; P. U. R. 1915 F 768, and *re* Pocatello Water Co., Idaho Supreme Court, 150 Pac., 47; P. U. R. 1915 F. 437) show a different attitude, for in both cases a value for the rights was allowed.

There has existed little doubt anywhere as to the necessity of giving proper attention to water rights since the United States Supreme Court held in 1914, in San Joaquin and Kings River Canal and Irrigation Co. vs. Stanislaus County (233 U. S., 459), that in spite of a declaration in the California constitution that water appropriated for sale was appropriated for public use, the benefit was private and the rights thereto should be considered in condemnation and rate cases. Mr. Justice Holmes thus speaks:

> But it is said that as the plaintiff appropriates this water to distribution and sale, it thereby dedicates it to public use under California law, and so loses its private right in the same. It appears to us that when the cases cited for this proposition are pressed to the conclusion reached in the present case, they are misapplied. No doubt it is true that such an appropriation and use of the water entitles those within reach of it to demand the use of a reasonable share on payment. It well may be true that if the waters were taken for a superior use by eminent domain those whose lands were irrigated would be compensated for the loss. But even if the rate paid is not to be determined as upon a purchase of water from the plantiff, still, at the lowest, the plaintiff has the sole right to furnish this water, the owner of the irrigated lands cannot get it except through the plaintiff's help, and it would be unjust not to take that fact into account in fixing the rates. . . . It seems unreasonable to suppose that the constitution meant that if a party, instead of using the water on his own land, as he may, sees fit to distribute it to others, he loses the rights that he has bought or lawfully acquired.

This case is widely quoted as controlling. The question now is not whether any water right is to enter rate basis, but how much should be allowed. The hesitant attitude of public representatives as to amount is well expressed by the New Hampshire Public Service Commission when it states (*re* Grafton Electric Light and Power Co., 4 N. H. Pub. Serv. Comm. Rep. 178):

> The objection of the Supreme Court to the conjectural character of the cost of reproduction method [of valuing property in the Minnesota Rate Cases] applies with equal force to

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†Associate Editor, "Engineering News," New York City.

the "saving-over-coal" method of valuing water power. It assumes, what is not proved, that power could be produced profitably by coal, and it assumes, what is not true, that a given amount of power produced by water varying in amount, as it will on even the best-regulated streams, is equal in value to a like amount of power generated by steam, constant and reliable at all times.

We live in a region remote from the coal fields, the cost of transportation is heavy, and the price of coal is higher than in almost any other part of the country. On the other hand, ours is a mountainous state with many streams having a large fall and furnishing an abundance of water-power, much of which is still undeveloped. . . . A fair value of a water power in New Hampshire cannot be a value which takes no account of our natural resources and makes electricity produced by water as expensive to the public as if produced by coal.

The Vermont Public Service Commission also expressed the same hesitancy in *re* Montpelier & Barre Light and Power Co. (No. 452, 1916; P. U. R. 1916 B 973), as follows:

The commission, however, entirely disapproves of this method of determining the value of water rights [by direct comparison with steam] because, in our opinion, it creates a value which may be largely in excess of the actual value of the rights and because this method, if applied to rates, would entirely deprive the consumer of any benefits to which he is entitled by reason of having these natural resources at hand.

Rights as Real Estate

At the outset it should be stated that authorities are universally agreed that water rights are property having essentially the nature of real estate—industrial real estate. Therefore they are valuable in accordance with their power to produce income.

The Idaho commission in valuing the water rights of a hydro-electric company (Taylor vs. N. W. Light and Water Co.; Idaho Pub. Util. Comm. Order 297; P. U. R. 1916 A 372) refused to allow a value where it transpired that the company could purchase cheaper than it could develop.

But this value of earning power must be separated from the common intangible values also generally recognized by their earning power or by investment. Even where such procedure is followed, the greatest variation is seen in the results of its use by different persons. The appraiser with sympathies running in one direction seems apt to make value large enough to compensate the holder for amounts more desired than supported by fact. The appraiser of opposite sympathies seems to minimize the value of water rights where these can be construed as depending in any measure on public grants. As is usual on such controversial matters, the actual truth in any specific case generally resides in a somewhat indefinite middle ground and can be approximated only by the exercise of good judgment as well as the study of specific data.

If water rights are essentially of the nature of real estate, it would be expected that they should be valued like real estate by the direct comparison of sales. However, this method, in simple form, is extremely restricted for the study of water-power rights; exchanges are extremely few in number compared with the parcels of land that are traded every year. Moreover, in comparing the values of real estate it is essential to take into account transfers of land in the immediate vicinity of the parcels studied. That seldom is possible in the case of water powers, and in making any direct comparison of sales the geographical separation usually will be sufficient seriously to impair the validity of the appraisal—unless such effects as different cost of development, different annual return, different market conditions and different probable net profit are brought into play. But the handicap of geographical separation may be overcome by scientific analysis preceding the attempt at comparison.

Splitting the Value of Rights

Water rights, it has been stated already, exhibit the peculiarities of *industrial* real estate in that the value depends on utility for special service. Indeed, consolidated water rights may be regarded as the enhancement of value of land well situated for the special use of generating power from falling water, etc. The enhancement from these special uses is far greater than the value of the real estate for all the ordinary uses of land, so that the common value of the tracts is generally neglected as inconsequential.

This enhancement consists of two elements of value, the first depending on the physical conditions which lead to ease or difficulty (measured by expense) of developing the rights. The second depends on the demand for water or power in the locality, and the kind and cost of power that predominates to rule the market. The two values are not wholly independent, for where there is competition with steam power, the second element increases with any decrease in cost of development.

These value factors we may call[1] "constructional" and "regional." In case either factor is zero, the value of the water rights is zero. For instance, the many water powers hundreds of miles back from even moderately populous areas have little or no regional value at present, and the value of the water rights is inappreciable in spite of possible high constructional value. The numerous water powers of the Adirondack region of New York have no local market and cannot be completely developed to compete profitably with steam power in the metropolitan markets; the regional value is low. If it were sought to dam the Hudson River and develop power anywhere near New York City, the regional value would be great, but the constructional value obviously would be zero, so great would be the legal, engineering and financial obstacles.

Comparing Two Rights

If an engineer has data at hand on the sale prices of scattered water rights, the unknown value of a questioned private water right can be approximated by increasing or decreasing the known value in proportion to (1) the size of the possible development, (2) the difference in regional value and (3) the difference in constructional value. Much the same sort of scheme would be employed by an experienced engineer, the rights of actual scattered plants taken before for comparison being replaced by those of an ideal normal plant existing in the mind of the appraiser. It might be thought that the problem could be approached also by setting up for comparison a hypothetical plant of the specific local capacity, built under local hydraulic data but under fixed difficulties and at specific cost, and finally having a specific market and specific income. For such a plant there could be computed a net income and the water rights would depend on this—being in the nature of real estate which is valued by its earning power. Then the real water rights could be approximated by changing

[1]Following the nomenclature employed by Robert E. Horton, Consulting Engineer, Albany, N. Y., in recent cases.

this value to accord with greater or less construction difficulties which developed, and for more or less favorable market conditions which arose. But this last study reduces more or less to appraisal by earning capacity.

Valuation of Rights by Earning Capacity

Where there are no dependable data for the method of appraisal by sales comparison, it is necessary to fall back upon an earning-capacity study. At the outset it is necessary to start with the query: What sum could an intending purchaser afford to pay for consolidated water rights going with a diversion for power or water-supply, knowing the gross income which the power or water will bring, knowing that certain fixed charges, interest and taxes must be paid on the full investment—including land and water rights and the cost of plant and business development? All the factors entering into the solution of the problem are known but one—water rights—and the answer is therefore ascertainable.

On the basis of earning capacity, the capitalized net profit is equal to the cost of the physical plant and going-concern value (the latter estimated for an undeveloped business by any of the acceptable methods) plus the water rights in question. The net earnings, or profit, in turn are the gross annual earnings less the annual operating cost, depreciation compensation, supervision, repairs, etc., and less the interest and taxes on plant (structural) value, going-concern value and worth of water rights. This is briefly and simply stated[2] as:

$$S + G + W = \frac{P}{N} = \frac{I - O - (S + G + W)(R + T)}{N}$$

whence

$$W = \frac{I - O - (S + G)(N + R + T)}{N + R + T}$$

where P = annual net profits, W = water-rights value, I = annual gross income, O = annual operating expenses, S = structural cost, G = going-concern cost, N = capitalization rate, R = fair return on investment, T = tax rate.

The warning that needs to be made in the use of the earning-value method is that appraisers have seemed apt to under-estimate the annual operating expenses and so over-estimate the profits and the value of water rights.

Short-Cut Steam-Power Comparison

The gross annual income of a water-power plant in the East is tremendously affected by the cost of steam power. There are few hydro-electric plants where a considerable proportion of the output does not compete with steam drive directly. Even where the service is for lighting, the price is limited to that of possible local steam-plant current. Therefore, there has been used in the East a short-cut scheme of appraising water rights by capitalizing the difference in cost of output between the hydraulic plant and an equivalent steam plant in the same district. This may be permissible at times, but it is not to be universally recommended as it substitutes an extreme hypothetical condition where a closer approach to actuality is possible. Public hostility to it has already been noted. For instance, with utility regulation, even in the East, the tendency of rates is toward cost of service, including therein a reasonable return on the property employed. The regulated rates are not directly or fully related to the cost of steam power. (The off-peak factory-drive competitive business, however, is secured only by cutting under steam-power costs. The off-peak commercial business operates to reduce the general cost of service by giving more constant utilization of the plant and diluting the overhead expenses with small additional profits.)

The desire to use steam-power costs in the valuation of water rights springs out of the convenience of such comparisons rather than rising from their applicability. The capitalized annual cost of operating and maintaining in perpetuity a profitable steam plant to produce an amount of energy equal to that which can be produced at a given water power generally will prove larger than the similar figure for a water-power development, the water rights of which are determined by weighted comparison of sales or by study of actual earning power. Therefore the value of water rights determined by such steam-power cost comparisons may be expected to be often large enough to prove an embarrassment to the owners in time of protracted business stagnation, financial depression, strikes, war, unfavorable legislation, strict regulation or poor internal management. When this scheme is or has been employed, care should be exercised to see that the valuation of water rights and plant plus capitalized operation and maintenance costs does not exceed the capitalized sum which would maintain and operate the equivalent steam plant *not continuously, but for such portion of the time as the water-power plant could reasonably be expected to operate under the unfortunate contingencies noted.* The necessity for such a scrutiny may be realized when it is recalled that the investment costs, which continue always, are high for the water-power plant and low for the steam plant; the operating expenses which may be curtailed during depressions are small for water-power and large for steam.

Value of Rights Under Regulation

Many believe that the valuation of water rights in the Western states must be on a different plane from that in the East. There is nothing seen, however, in the sales-comparisons or earning-value plans of appraisal but what can be followed in one section as in another.

Some publicists claim that as the water rights came from the public and are used for the public good, no value should be allowed the utility company for those rights. The actual conditions under which public grant of water powers has been made need to be considered, of course. It is conceivable that in some cases the public desired that the company should earn on its investment and activity, but not on the fundamental land and water rights. Where that view actually prevails, obviously there can be no water right owned by the utility company. Where such a condition has not been found, the appraiser has to find earnings even under rate regulation. This is difficult, for he has to avoid a reasoning-in-circle situation. That is, if he takes rights through rates based on a worth which includes value of water rights, the larger the value of those rights the higher the rates must be; then the larger becomes the value of the rights again and the higher the rates, and so on. The only escape usually is to consider what the water rights would be in private service.

The concern may have obligated itself to serve the public when it might have continued to give private

[2] Following a form suggested by Robert E. Horton.

service in large blocks; then the water rights ordinarily should be considered as before the public service became predominant. Surely neither the company nor the public expected that the company would be penalized for furnishing a multitude of users instead of the few. The right to use water for private gain of course is as legitimate as the right so to use land. Care has to be taken to insure that the estimate of earnings on a private-business basis is strictly consistent, that it does not include income-rate enhancement promoted by public assistance marking the change from private to public utility—like occupancy of streets or of power of eminent domain.

There are various ways away from reasoning in a circle when the very earnings to be taken in the earning-power method are under attack as unreasonable. First, it must be ascertained what peculiar status any Federal and state legislation may give the water rights; or what specific franchise contracts may affect them so that they may be declared nonexistent, existent but partly dedicated to public benefit, or existent and entirely in private possession.

If existent and in private seizure, in most cases there appears to be no escape from the higher prices due to earnings on water right. A parallel case exists: A state may have given away its valuable mineral land to any who would develop, and it cannot but endure the situation as to old land patents, though it can demand a share of the profits in land yet ungranted. It is the same way with water rights in many cases. Legislatures may have the right to cancel the rights by repayment.

The actual estimation of probable earnings of the rights under purely private industry may be arrived at in some cases, for instance, from the figures available from the private utilization of part of the water rights as leased to others.

The "value" obtained in the ways and under the conditions noted is in reality more than simply worth of water rights. It has been noted that it includes, first of all, the relatively unimportant value of the appurtenant land for common uses. If the plant is already built and in operation, the value may often also include a factor depending on the brains worked into the design, construction and operation.

The separation of the value of the real estate for building or agricultural purposes may be carried out with reasonable simplicity, but the value of applied mentality is very difficult to separate from the water rights. Therefore it is common to allow all of these accompanying values to remain consolidated with the value of water rights, and no case is recorded of resulting injury. Care must be exercised not to admit the same application of mentality in two separate parts of a utility valuation.

A Water-Rights Fallacy

In actual cases there are marked differences in the opinions and procedure of the different sides. For instance, in condemnation proceedings the owners frequently compute the annual cost of their power so as to include the interest and taxes on only structural investment—purposely neglecting charges on water rights. They then subtract this cost of their water power from the annual cost of some substituted form of power, like steam, and arrive at an apparent annual profit which they capitalize at 8, 6, 5 or 4 per cent. The resultant figure is their contended value of water rights. This procedure is defended on the claim that since they own the water power they are not paying interest on the rights, and it should not be charged against them in comparing the cost of water power *to them* with the cost *to them* of some substitute power.

Obviously such a procedure is most unsound. If the water power were worth all that is shown by such a series of computations, the plant and rights could be sold and the money invested in Government bonds to bring by pure interest an annual profit as great as could be secured after undergoing the risks of development.

On the other side of such condemnation cases, the would-be seizors claim that the value of water rights cannot exceed a sum which a purchaser could afford to pay if he borrowed all the funds for acquisition of rights and development of plant, and if the enjoyment of the rights enabled him to derive a small safe profit in return for service in promotion and management and as a guarantee of permanent ability of the works to afford enough revenue to cover interest and depreciation indemnity.

Valuation of Storage Reservoirs

A problem now becoming pressing is the valuation of storage-reservoir sites. In a few cases the estimated or experienced total annual gross return from the increase in available power over that of no storage has been capitalized to secure this value (with or without deducting investment charges on the reservoir) on the evident assumption that there would be no increase in size of generating plant or in the operating expenses. It is more conservative, but not wholly satisfying, to capitalize the net annual earnings from the increase in power. A still more rational procedure would be to compare the entire situations with and without storage; then the value of the storage site might be, as a maximum, the capitalized difference in net earnings of the larger works with storage (deducting all operating costs and fixed charges on generating station and storage works complete) and of the smaller plant that would have been built if storage had been impossible. In securing these net earnings it hardly need be said that recognition must be given to the amounts of primary, permanent, assured or continuous power and of secondary, nonpermanent, unassured or noncontinuous power produced under the two conditions of storage or no storage.

Where one reservoir benefits a string of plants scattered downstream, it is common to state that the value of the storage depends on the amount of fall through which the impounded waters may be utilized. As a quantitative statement this may be inaccurate, for the general benefits of storage decrease with the distance downstream. This is due, first, to the fact that the impounded waters form a smaller and smaller proportion of the stream flow as added units of drainage area pour their runoff into the stream. It is due also to the disturbing influence of local-plant pondages below, especially where they do not operate alike at simultaneous hours or where they are not under the control of a single load dispatcher. The value of the reservoir site then is not the sum of capitalized net earnings of each plant assumed to secure full benefit of the stored water; it would depend upon the somewhat complex and difficultly ascertained difference in net earnings for the entire existing or probable situation of all the plants as a unified system with and without the storage.

Canadian Society Fixes Fees for Engineering Service

The Association of the Alumni of the Ecole Polytechnique of Montreal (Anciens Elèves de l'Ecole Polytechnique de Montréal) has issued a code of professional ethics and list of fees. The code sets down the usual ethical considerations, distinguishes between a "consulting engineer" and an "expert engineer" and outlines their respective duties. The most interesting part of the paper is the tabulation of fees. These are as follows:

For simple consultation the charge to the client will be proportioned to the time spent on the work, the basis of the charge to be a day of 6 hr., remunerated at a rate of $50 to $100 a day, depending upon the importance and experience of the engineer. If his experience and reputation justify it, a larger charge may be made. For fractions of a day, charges are as follows: $30 to $60 for a half-day; for a lesser portion, $15 to $25 per hr.

For a written report the following charges are to be made: For preliminary study of a project with a report, or for an examination of a project prepared by another engineer, with a report on the subject; for a study and report on questions of litigation; for preparation of depositions before courts; presence in courts during trial—$50 to $100 a day or more for the first five days devoted to the client and $25 to $50 a day for the next succeeding days. The client shall in addition pay all the salaries of assistants and an additional amount equaling 100% of those salaries to cover the overhead expenses of the engineer's office.

The working day of an engineer shall be 6 hr.; and when he is absent from his home city, his charges per day shall be based on the charges for the first five days' work as previously noted, and every day of 24 hr. or fraction of such day is to be considered as a day to be paid for without regard to whether the time is actually devoted to the study of the project in hand.

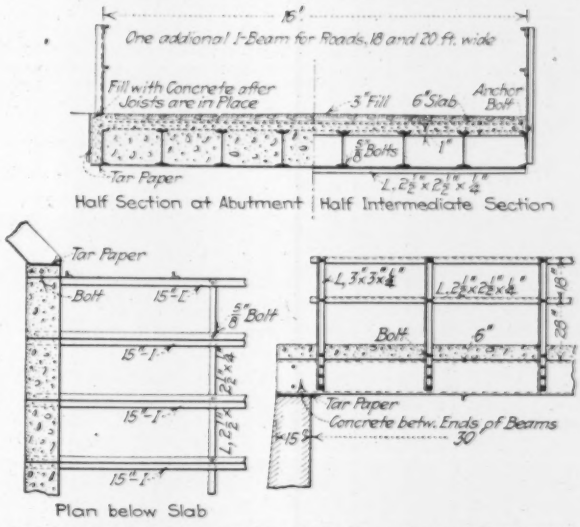
In some cases a consulting engineer is justified in charging a percentage of the actual cost of the enterprise under consideration. On such a basis the following charges may be made: For the preparation of a project, or the examination of a project prepared by another engineer, charges for services of the engineer and of his personnel shall be equal to 2% of the possible cost of the enterprise, if this total not more than $50,000 or less than $10,000. For all projects of probable cost of less than $10,000 the remuneration shall be at least $200. For projects of $70,000 to $100,000 the percentage shall be 1½% of the cost; for projects of more than $150,000 the percentage shall be 1% of the cost.

For preparation of designs for construction the fee of the consulting engineer and his personnel shall be as follows: 3% of the cost of the work, if $50,000 or less, with a minimum fee of $300 for work under $10,000. For projects of more than $70,000 and less than $1,000,000 a fee of 2½%; and for projects of more than $1,000,000, 2%. When superintendence of the work is included, the following charges should be made: Partial superintendence, comprising consulting work in the engineer's home office and some visits to the work during its execution, from 3 to 2% of the cost of the work. Complete supervision, comprising office consultations, visits to the work and superintendence of the execution by a representative of the engineer, control of the contractors, etc., from 5 to 7%, 5% applying to work of $1,000,000 or more, 6% to from $100,000 to $500,000, 7% to under $60,000. The minimum fee shall be $700.

Steel I-Beams and Concrete Highway Bridges

Highway bridges with I-beams resting on concrete abutments and carrying a concrete slab floor are used extensively in Iowa. The accompanying drawing represents one of a number of such bridges designed by John A. Illeman, County Highway Engineer of Boone County, Iowa.

The design covers spans from 16 to 35 ft., using 9-in. 21-lb. beams for the former and 15-in. 42-lb. beams for the latter. There are six beams for 16-ft. roads and seven for 18- and 20-ft. roads. In all cases the sides of the roadway are carried by channels of the same depth as the I-beams. Two transverse angles are bolted to the



HIGHWAY BRIDGE WITH I-BEAMS AND A CONCRETE DECK

bottom flanges of the beams and channels. Vertical angles riveted to the channels (and bolted to the concrete floor by long bolts) form the posts of the angle-iron hand-railing.

The deck is a concrete slab 6 in. thick, with its lower face 1 in. below the tops of the beams. It is reinforced by ½-in. transverse rods in the top and bottom, spaced 12 in. c. to c. (staggered) and ½-in. longitudinal bars, there being one longitudinal bar in the space between each pair of beams. The edges of the slab are 9 in. thick, forming curbs to retain a 3-in. fill of road material (usually gravel). Weep holes of 4-in. tile are provided for drainage, spaced 6 in. from the curb and 10 ft. c. to c.

At the abutments three layers of tar paper are placed on the bridge seats under the ends of the beams, and concrete is filled in between the ends of the beams, as shown. Tar paper is placed between this concrete filling and the wing-wall.

The bridges are designed to carry a 15-ton traction engine, with 11-ft. wheelbase and driving wheels (22 in. wide) spaced 6 ft. c. to c. The load is assumed to be 10,000 lb. on each driving wheel and 5,000 lb. on each front wheel.

Long-Span Howe Trusses Fail

An unusually heavy fall of snow, most of it drifted on one side of the roof, caused the complete failure of a number of 110-ft. Howe trusses designed to support the roof of the Majestic dance hall, Salt Lake City, Utah. The accident occurred immediately after the snow storm of Mar. 25. It happened that no one was in the building at the time, although the very large hall (about 250x150 ft.) was regularly used for roller skating and dancing.

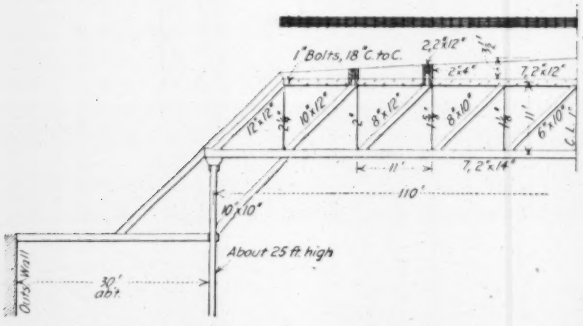


FIG. 1. SKETCH ELEVATION OF HOWE ROOF TRUSS, 110-FT. SPAN, WHICH COLLAPSED

The building was a frame structure completed only about two years ago. The main part of the hall was about 200 ft. long, roofed over by a series of 10-panel timber Howe trusses of 110-ft. span, spaced 16 ft. c. to c. The trusses rested on 10x10-in. posts, and carried the roofing by purlins at the panel points, supporting secondary rafters. The outside purlins rested on the upper chords and the center purlins on posts which raised the roof about 3½ ft. above the top chord.

The architect, B. O. Mecklinberg, Salt Lake City, declined to allow the details of the truss to be published, but the accompanying sketch, Fig. 1, gives the essential elements, based on the measurements and observations of those in charge of the wrecking and reconstruction of the building. The view, Fig. 2, taken by a local photographer immediately after the collapse, shows a truss at the east end of the hall which did not collapse.

The trusses as already noted were of 110-ft. span in 10 panels of 11 ft. each, and were 11 ft. deep, center to center of chords. The lower chord was built of seven 2x14-in. planks and the upper chord of seven 2x12-in. planks bolted together by 1-in. bolts spaced 18 in. c. to c. and staggered. The planks composing the chords were Oregon fir, surfaced on both sides and edges, so that their actual dimensions were not more than 1⅝x13⅝ in. and 1⅝x11⅝ in. In computing the cross-sections of the chords 1½x13½ in. and 1½x11½ in. were the dimensions used.

The diagonals were 12x12 in. at the ends, 10x12, 8x12, 8x10 and 6x10 in. from ends toward the center respectively. These were solid members mortised into the chords, without the use of castings at the panel points. The vertical rods were 2¼, 2, 1⅝, 1⅛ and 1 in. respectively from the ends toward the center. The roof purlins were two 2x12's supported by two 2x4's nailed or spiked to either side of the top chord.

As to lateral bracing between the trusses many conflicting statements are made. No design was made for this, and such as was put in is not a matter of record. Those in charge of clearing up the débris stated that there was no bracing whatsoever, and that the trusses depended entirely on the purlins, ceiling, rafters and bracing between the posts for lateral support. This seems hardly possible, yet there is no evidence of other bracing in the views taken immediately after the collapse.

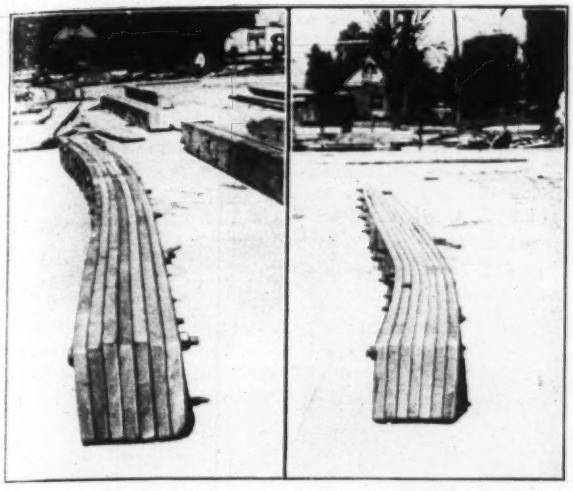
The failure was caused in almost every instance by the buckling and breaking of the top chord. Many of the posts on the north side of the building broke off below the kneebraces and the north wall fell outward as shown in Fig. 3. The bulk of the snow load was on the opposite or south side of the roof. The general impression seems to be that the initial failure was in the chords, although the posts must have been subjected to a considerable bending moment.

Those familiar with the condition of the trusses previous to the collapse believe that they were on the point of failure for a long time. Construction of the building was a rush job at the beginning of a season and everything was ahead of the plans. The timber was green, as

FIG. 2. EAST END OF BUILDING, SHOWING SINGLE REMAINING TRUSS AFTER COLLAPSE OF ROOF

nearly all available lumber is. It is said that ¼-and ½-in. shims were used in some of the mortised joints between chords and diagonals. In the top chord there were instances where the joints in the two outside planks came opposite each other. A section of such a chord was observed during the wrecking operations, May 9.

FIG. 3. NORTH SIDE OF BUILDING PUSHED OUTWARD



FIGS. 4 AND 5. VIEWS OF TOP-CHORD SECTIONS, SHOWING PERMANENT WARPS OR BENDS

When completed the trusses were ceiled off from the space below. Electric lights placed in the space between the ceiling and the roof for the purpose of showing the condition of the trusses were subsequently removed. The hall below was steam-heated, making this ceiled compartment above, containing the trusses, extremely hot and dry. Conditions were therefore ideal for a maximum amount of shrinking and warping. It appears that nothing was ever done in the way of tightening rods and bolts, and that long before the collapse occurred and during all the time the hall was in use many top chords were observed to be out of line by as much as 6 in., forming irregular wave-lines in ground plan. The condition of these top chords when the collapse did occur is shown clearly enough in Figs. 4 and 5, which are sections not more than two panels long. Moreover, several sections were warped also in the vertical plane. The amount of shrinkage in the length of the planks was plainly discernible in the wide openings at butting ends.

The designer was aware of these conditions and urged the owner (it is claimed) to bring the top chords back into line with turnbuckles and have them properly braced. In the meantime the holding company went through bankruptcy proceedings and the building changed hands. Nothing was done to strengthen the roof trusses and the new owner threw open the doors of the building as a roller-skating rink.

The original design was passed upon by the city building-inspection department, but no subsequent investigation was made. Owing to the fact that no lives were lost there is little local interest in the failure, and the building-inspection department has never made more than a cursory examination to determine the cause; the results of this examination are not made public. As is perhaps natural in such a case there is an evident desire on the part of all concerned to let the matter rest, and the foregoing facts were obtained only by careful inquiries and painstaking search in the field, which will explain the absence of data which would be of value.

The building is to be reconstructed on approximately the same lines as before, but the roof will be carried on two-hinged timber latticed arches of the same (110-ft.) span. The architects for rebuilding the structure are Scott & Welch, Salt Lake City.

Unit Stresses in the Design of Car Truck Frames

In the evolution of railway rolling stock nearly all the progress has been the result of a cut-and-try process. Parts have been dimensioned according to judgment and experience, and until recent years little attention has been paid to computations of stresses and proportioning of parts in accordance with the computations. One reason for this, of course, is the impossibility of any accurate determination of the stresses that result from dynamic action and shock. It is now generally recognized, however, that approximate computations of stresses are of great assistance in the intelligent design of rolling-stock parts and still give ample room for good judgment in the adoption of final proportions.

Interesting figures have just been made public concerning the unit stresses adopted in the design of the "Fox" type of pressed-steel pedestal trucks, manufactured by the Pressed Steel Car. Co., of Pittsburgh, Penn. While this type of truck has been in extensive use in freight-car service for some 20 years, material changes in the design have been made during that time, not only in general dimensions to correspond with the increased weight of rolling stock, but in the details of various parts to enable them better to withstand shock and distortion.

Each side frame of these trucks is designed to carry a load placed at its center equal to the full M.C.B. rated carrying capacity of both axles of the truck. Under this load the fiber stresses in the truck frame must not exceed half the elastic limit of the metal. In other words, the side frame is designed for double the static loading permissible under the Master Car Builders' rules. This excess of strength is provided to resist vibration, shock, lateral thrust on curves, and other stresses that may occur in excess of the static load. The truck transoms are likewise designed so that the maximum static load which may be imposed upon them will produce a fiber stress not exceeding one-fourth the elastic limit of the metal.

Some Significant Water-Works Census Averages

By Charles W. Sherman*

Engineering News of May 18, 1916, called attention to the appearance of "General Statistics of Cities: 1915," from the United States Bureau of the Census. Certain average statistics relating to water-works, computed from the report, are of sufficient general significance to warrant their presentation separately. Group I includes two cities having populations in excess of 500,000; Group II, 10 cities, 300,000 to 500,000; Group III, 9 cities, 100,000 to 300,000; Group IV, 12 cities, 50,000 to 100,000; and Group V, 35 cities, 30,000 to 50,000 population.

PER CAPITA WATER-WORKS AVERAGES, BY POPULATION GROUPS

	I	II	I.I	IV	V	Aver.
Capacity of impounding reservoirs, gal.	19,000	46,000	21,000	49,000	19,000	23,000
Capacity of distributing reservoirs and standpipes, gal.	420	500	390	310	520	420
No. of days' supply	2 8	3 3	3 0	2 5	4 1	3 0
Distribution System—Main Pipes and Hydrants:						
Persons per mile of pipe	1,020	610	530	530	390	690
Hydrants per mile of pipe	11 3	8 1	8 3	7 4	6 8	8 9
Hydrants per 1,000 persons	11 0	13 2	15 6	13 9	17 2	13 0
Value of water-works (estimated) †	$45	$45	$39	$34	$38	$42

† These figures would be somewhat increased if the value of the water-supply works of the Metropolitan District of Massachusetts were included.

*With Metcalf & Eddy, Consulting Engineers, 14 Beacon St., Boston, Mass.

Field and Office

Tremie Plant for Concreting Subaqueous Pedestals*

By Kirby Smith†

In the construction of an extension to the boathouse at the United States Naval Training Station, Newport, R. I., a special concreting plant was installed to place the under-water piers or pedestals upon which the columns of the buildings foot. The project provided for 12 concrete and granite piers, ranging in overall height from 8 to 14 ft., the granite extending from El. —0.5 to El. +4.92. This type of pier was proposed because of the excessive ice action at the location of the boathouse, due to the shallow water and strong currents through the boathouse channel. A typical pier is shown in Fig. 1.

Several methods were considered for the placing of the concrete, including (1) premolding, (2) the use of a coffer-dam, and (3) tremie. The first method was rejected as impracticable, because of the uncertainty of the bottom elevation, making it impossible to determine the exact size of blocks, and because of the difficulty of placing and aligning accurately after casting; the second was given up because of the excessive cost and the lack of such apparatus as pumps, a piledriver that would handle sheeting, etc.; while the third—pouring in place by tremie—was decided upon as being the only feasible method, considering the nature of the work, the location, the cost and available plant.

The excavation was made with a ½-yd. bucket mounted on a small power derrick. The material excavated was soft silt and gravel. As the excavation for each pier was completed, the form, having been previously built, was placed. All forms were carefully made of 2x6-in. tongued-and-grooved yellow pine with 4x4-in. rough corner braces. The lower ends of the corner pieces extended about 6 in. below the form proper. After placing, dredged material was backfilled around the lower part of the form to prevent the concrete from working out and to keep the form from moving laterally while pouring. Eight 90-lb. lead mine weights were hung on the outside of each form to overcome buoyancy.

The layout of the plant (Fig. 2) consisted of a ½-yd. Austin concrete mixer operated by a 10-hp. gasoline motor, a 15x30-ft. steel float carrying the fixed tremie hopper and frame, and a large floating piledriver on which was rigged a jury boom carrying a 9-cu.ft. concrete bucket. A 15-in. tremie pipe was used, suspended from the underside of the fixed hopper by two 3-ton differential hand-operated tackles, capable of raising the tremie easily and rapidly when full of concrete. The tremie was in two sections, one piece 15 ft. long and one piece 2 ft. 6 in., the smaller section being used with the 15-ft. piece to secure sufficient length for the deepest forms. To the upper part of the tremie pipe was attached a hopper 3 ft. high, 36 in. in diameter at the top. The upper, or fixed, hopper had a capacity in excess of the volume of the larger section of pipe. This capacity was necessary in order to insure filling the tremie above the height of the water with the first batch of concrete.

A 1:2:3½ concrete was used. The stone was crushed granite 1 in. and down; sand ¼ in. and under, clean and very well graded. The resulting mix flowed and handled well and remained plastic for a considerable length of time. The concrete was conveyed from the mixer to the bucket, on the lower platform, through a tin-lined wooden chute 12 in. wide and 10 in. deep, the flow being regulated at the mixer. To prevent loss of concrete, however, the lower end of the chute was fitted with a sliding gate and the sides increased in height to 24 in.

The concrete was carried from the loading platform to the large upper hopper by the improvised derrick boom on the piledriver (Fig. 3). The flow from this hopper into the tremie was regulated by a flat slide valve operated from the platform at the top of the tremie frame. When the large hopper, holding about 25 cu.ft., was filled with concrete, the tremie was lowered to the bottom, then raised so as to be just clear. A sack filled with hay was then placed in the tremie, floating at the surface of the water. The valve in the upper hopper was then quickly

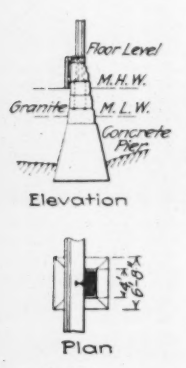


FIG. 1

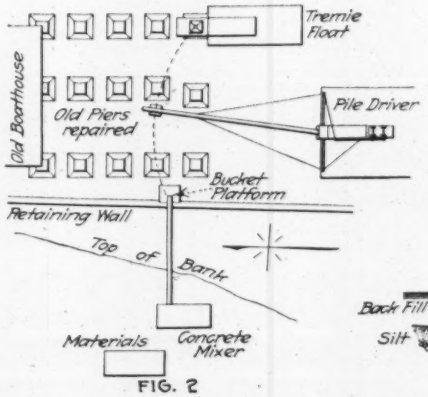


FIG. 2

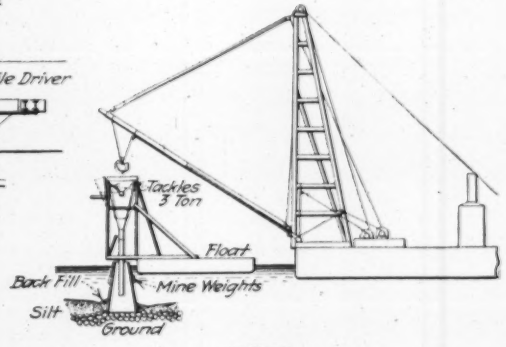


FIG. 3

*Civil Engineer, United States Navy, Newport, R. I.

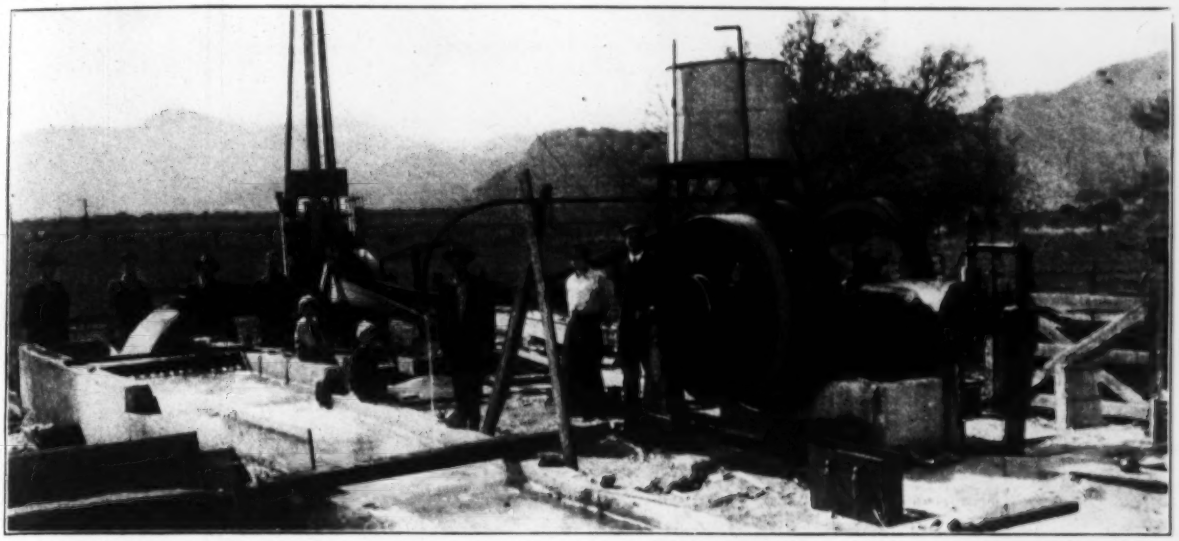
†From Bulletin No. 22, Public Works of the Navy, March, 1916.

opened wide; the flow of concrete forced the bag to the bottom of the pipe, carrying all water out with it. When the tremie was filled to a point about 2 ft. above the outside water surface, it was slacked back so as to rest on the bottom, checking further flow. As more concrete was deposited in the upper hopper and allowed to flow into the tremie pipe, the tremie was slightly raised, permitting the concrete to flow out into the form. After the form had started to fill, the bottom of the pipe was kept submerged in the concrete about 12 in. In this way one surface only was presented to the action of the water. Great care had to be exercised in regulating the height of the tremie, especially when concrete was discharged from the upper hopper, as, with the release of weight of this concrete from the smaller scow, the scow would rise quickly, carrying the tremie with it. Fortunately, only once during the entire work was the concrete in the pipe lost.

The pouring of two piers a day was considered good progress, as the work had to be conducted only at favorable stages of the tide. The form was filled to about mean low water and then later cut off to the required elevation. This insured a firm, hard base for the granite.

The granite was placed from a small wooden float on which a hand derrick was rigged. The cost of the work, including the cost of rigging the piledriver, building frame for tremie, and cost of the tremie, follows:

	Quantity	Unit Cost	Material	Total Cost Labor	Total
Excavation	150 cu.yd.	$1.65 per cu.yd.	.....	.....	$253.52
Forms.....	1,440 sq.ft. contact	0.147 per sq.ft. contact surface; $1.93 per cu.yd. concrete			
	3,640 ft. b.m.	0.058 per ft. b.m.	$104.80	$106.56	211.36
Concrete...	109 cu.yd.	9.91 per cu.yd.	503.90	577.35	1,081.25
Granite....	25 cu.yd.	23.86 per cu.yd.	422.10	174.50	596.68
					$2,142.81



IRRIGATION PUMPING PLANT OF GUILD FARMS CO. NEAR TUCSON, ARIZ.

Pumping Plant for Small Irrigation Projects

A type of pumping plant which is becoming extensively adopted in the Southwest is shown in the accompanying illustration. Plants like this are used both for small public water-supplies and on irrigation projects. The use of these small isolated plants for pumping ground waters makes possible the reclamation of many thousands of acres of land in California, Arizona, New Mexico and western Texas, which are not and probably never could be included in projects larger than a few hundred acres.

The plant illustrated is typical of the most recent development in this branch of irrigation engineering. It was completed in January for the Guild Farms Co. for the irrigation of about 380 acres of alfalfa and grain lands situated 20 mi. northwest of Tucson, Ariz., in the Santa Cruz valley. The pumping machinery, engine, etc., cost about $4,000 and the well, including drilling and casing with hard-steel stove pipe, 12-gage, cost $7.50 per ft. for the 24-in. section and $5.25 per ft. for the 16-in. section. The total depth of the well is 170 ft., of which 70 ft. is 24 in. and below that 16 in. The cost of the water-supply, including everything, was therefore about $5,000.

The normal level of the water in the well is 53 ft. below the surface. The pump is a two-stage 24-in. centrifugal running at 980 r.p.m. on a vertical shaft in the well, 70 ft. below the surface of the ground. These pumps are made by the Layne & Bowler Co., Houston, Tex. The plant described was installed by the Schweitzer Machine Co., of Tucson and Phœnix, Ariz.

The power is a 60-hp. 4-cycle oil engine made by the Western Gas Engine Co., Los Angeles, Calif., of which the fuel consumption is 6 gal. per hr. (38° Baumé). The well shown was tested by continuous pumping at the rate of 1,900 gal. per min. for 8 days, during which the water was drawn down 17 ft., making the average lift 61 ft. The length of the suction pipe was made 35 ft. The water is pumped into a concrete flume having a permanent weir. Water for domestic purposes (stored in the 1,000-gal. tank shown in the background) and for cooling the engine cylinder is pumped from the flume by means of a 2½-in. centrifugal pump. The pump and engine were subsequently housed at an additional cost of about $200.

It has been found that success in this class of irrigation requires the services of experienced engineers, and the farmers and ranchers are coming to all this. The preliminary work requires a thorough knowledge of the